ACTA AGRONOMICA
ACADEMIAE SCIENTIARUM HUNGARICAE

REDIGIT
S. RAJKI

TOMUS XVII FASCICULI 1—2

AKADÉMIAI KIADÓ, BUDAPEST
1968

ACTA AGRON. HUNG.

ACTA AGRONOMICA

A MAGYAR TUDOMÁNYOS AKADÉMIA AGRÁRTUDOMÁNYI KÖZLEMÉNYEI

Főszerkesztő:
RAJKI SÁNDOR

Szerkesztő:
PÁL GYULA

SZERKESZTŐSÉG ÉS KIADÓHIVATAL: BUDAPEST V., ALKOTMÁNY UTCA 21.

Az Acta Agronomica angol nyelven közöl értekezéseket az agrártudomány tárgyköréből, főképpen a mezőgazdasági alapkutatások területéről.

Az Acta Agronomica változó terjedelmű füzetekben jelenik meg, több füzet alkot egy kötetet.

A közlésre szánt kéziratok a következő címre küldendők:

Acta Agronomica
Martonvásár, Postafiók 19.

Ugyanerre a címre küldendő minden szerkesztőségi és kiadóhivatali levelezés.

Az Acta Agronomica előfizetési ára kötetenként belföldre 120 Ft, külföldre 165 Ft. Megrendelhető a belföld számára az Akadémiai Kiadónál (Budapest V., Alkotmány utca 21. Bankszámla 05-915-111-46), a külföld számára pedig a »Kultúra« Könyv és Hírlap Külkereskedelmi Vállalatnál (Budapest I., Fő utca 32. Bankszámla: 43-790-057-181) vagy annak külföldi képviseleteinél és bizományosainál.

The Acta Agronomica publish papers, in English, on agronomical subjects, mostly on basic research.

The Acta Agronomica appear in one volume (four issues) a year

Manuscripts should be addressed to:

Acta Agronomica
Martonvásár, Postafiók 19.

The rate of subscription to the Acta Agronomica is 165 forints a volume. Orders may be placed with "Kultúra" Foreign Trade Company for Books and Newspapers (Budapest, I., Fő utca 32. Account No. 43-790-057-181) or with representatives abroad.

ACTA AGRONOMICA

ТОМ XVII — ВЫП. 1—2

РЕЗЮМЕ

ЦИТОЛОГИЧЕСКИЕ ПОКАЗАТЕЛИ РОСТА КОРНЯ

II. Изменение содержания вещества и клетки сегмента кончика корня

М. МАРОТИ

Автор изучал в 1 мм сегменте и в разрастающейся части его у кончика корня проростка кукурузы темп роста, формирование популяции клеток и изменение содержания NS—P и протеин-N в зависимости от времени. Определено, что рост сегмента корня происходит в небольшой степени за счет деления клетки и в большей степени за счет растягивания клеток. Деление клеток происходит в 0,50—2,50 мм части кончика. Наибольшая интенсивность митоза находится в месте, которое занимает 1,25—2,25 мм. Растяжение начинается примерно через три часа после деления. К началу растяжения наблюдается 100%-ное увеличение веществ в клетках. Растяжение тесно связано с изменением состава и соотношения NS—P и протеин-N в клетках. Дифференциация клеток наступает через 7—8 час. инкубации, на расстоянии 5—6 мм от кончика. Влияние света проявляется в росте сегмента корня и в стимуляции клеточного деления.

СЕКТОРИАЛЬНОЕ НАРУШЕНИЕ ТРАНСПОРТА ПИТАТЕЛЬНЫХ ВЕЩЕСТВ У ОБРЕЗАННЫХ ПЛОДОВЫХ ДЕРЕВЬЕВ

БРУННЕР Т.

Автор изучал механическую водопроводящую способность и содержание кальция в близости плоскости среза и наблюдал за ходом зарастания окружности ран, нанесенных обрезкой. Установлено в ходе этих опытов, что нарушения транспорта веществ, вызванные обрезкой, носят секториальный характер и явление автором называется секториальным нарушением транспорта веществ. В качестве примера приводятся данные оценки ранений, вызванных только одним производственным разреживанием в плодоносящем саду сорта Йонатан. Учитываются и последствия секториального нарушения транспорта веществ.

НИТРИФИКАЦИОННАЯ СПОСОБНОСТЬ ПОЧВ БОЛОТНЫХ И УКОСНЫХ ЛУГОВ

М. КОВАЧ

В лабораторных условиях изучалась нитрифицирующая способность почв лугов типа Agrostion и Arrhenatherion из Задунайской части страны в зависимости от типа почвы. Сообщества этих ассоциационных групп можно отделить друг от друга по почвенно-экологическим особенностям и нитрифицирующей способности. Локально (особенно в случае контактных сообществ) на основе потребности в азоте можно построить экологический ряд растительных сообществ. Результаты анализов применимы и в практическом луговодстве (улучшение лугов).

ДАННЫЕ К ПОЗНАНИЮ САМООЧИЩЕНИЯ РЕНДЗИНОВЫХ ПОЧВ

И. САБО, М. МАРТОН, И. БУТИ

В нестерильных образцах рендзиновой почвы Aspergillus niger за 17 дней потерял 99,4% оригинального числа спор, а в стерильной почве в присутствии антагониста Streptomyces albosporeus штамм № 2—6 за 85 дней потерял 96%.

Sarcina lutea оказался в состоянии размножаться и в стерильной и в нестерильной почве. В случае же совместной культуры с исключительно сильным антагонистом Str. purpurescens, штамм 3—12, выделенным из той же почвы, на стерильной почве к 17-ому дню и следов Sarcina lutea не было.

Число спор Escherichia coli медленно снижается и в стерильной почве, на 85-ый день сохраняется 3% инокулума. Наличие антагонистов, лучистых грибов не или лишь незначительно ускоряло процесс уничтожения спор.

Самоочищение почв является чрезвычайно сложным процессом. Чуждые почве микробы изживаются прежде всего антагонистами, но естественная комплексная сапрофитная микрофлора может препятствовать проявлению эффекта антагонистов. Иной раз наоборот, самоочищение имеет место под синхронным влиянием ряда сапрофитных организмов в рамках биоценотического коннекса.

НЕКОТОРЫЕ НАБЛЮДЕНИЯ В СВЯЗИ СО СТРОЕНИЕМ ПЕСТИКА У HERACLEUM MANTEGAZZIANUM (SOMM. ET LEV.)

А. КОВАЧ, Ш. ШАРКАНЬ

Авторы изучали строение пестика у вышеназванного вида, используя для этого приготовленную серию срезов зачатков цветка. Определено, что в то время как в начале инициация пестика, пыльника и лепестковых бугорков происходит независимо друг от друга, позднее они развиваются сросшими конгенитационно (аппендикулярное строение) до тех пор, пока не образуется перегородка, разделяющая полость завязи, postgenitalis срастанием в период пликации при сворачивании краев лепестков. Результаты исследований не подтверждают того факта, что завязь является нижней, тем более, что стенка пестика представляет собой единую систему проводящей ткани и скорее говорит о характере листа.

ВЛИЯНИЕ ВОЗРАСТА КОРОВЫ НА СОДЕРЖАНИЕ БЕЛКА И КАЗЕИНА В МОЛОКЕ

З. ШАШВАРИ

Изучались возрастные изменения содержания белка и казеина в группах по отцу коров. Потомства произошли от скрещивания коров венгерской пестрой породы с быками F_1 от спаривания венгерской пестрой х джерзейской пород (полукровки от коров венгерской пестрой и быков чистокровных джерзейских) и с быками R_1 (четвертькровки по джерзейской и 3/4-кровки по венгерской пестрой породам от спаривания коров венгерской пестрой с быками первого поколения от спаривания венгерской пестрой х джерзей). Коровы были разных возрастов. Было установлено, что по мере старения среднее за лактацию содержание белка и казеина в молоке незначительно снижается. Снижение в опытах автора составляло 0,18% по белку и 0,09% по казеину к четвертой лактации по сравнению с первой.

ТЕХНИКА ПРИГОТОВЛЕНИЯ ТКАНЕВОЙ КУЛЬТУРЫ КАРТОФЕЛЯ В ТЕЧЕНИЕ КОРОТКОГО ПЕРИОДА

II. Эффект некоторых экзогенных и эндогенных факторов роста

Б. ФАЛУДИ

Необходимо обеспечить подходящее pH окружающей среды, которое было бы близко к pH ткани (в нашем случае pH — 6,2). Приготовленный из клубня картофеля материал соответствующим образом растет только в темноте. Было найдено, что оптимальная температура равна 23—26° C. Облучение клубня γ-лучами понижает на 40—60% влияние 2,4—Д оптимальной концентрации. Задерживающее влияние зависит в большей степени от времени облучения, чем от увеличения дозы в пределах 10—80 Кr. Непосредственное облучение культуры ткани показывает, что в период наибольшей стимуляции роста только довольно высокая доза облучения может ограничить стимулирующее влияние 2,4—Д. Оптимальный начальный вес, как было определено, равен примерно 25 г. Старались приблизиться к данной весовой величине увеличением как толщины слоя, так и площади основы. Исследования показали, что и толщина слоя, и площадь основы одинаково имеют большое значение. Оптимальной толщиной оказался слой в 670 μ, который комбинируется с площадью основы 5×5 мм. Неправильный выбор размера не только сокращает индекс роста и дает нежелательный коэффициент вариации, но и может вызвать демаркационные явления где-то вблизи границ оптимальных размеров. На соответствующий рост ткани оказывает влияние и продолжительность времени хранения, а именно: он действует по-разному при применении субоптимальной, оптимальной и тормозящей рост концентрации 2,4—Д. При применении оптимальной концентрации 2,4—Д в начале и в конце периода хранения стимуляция может быть наименьшей.

АНАЛИЗ ФОТОПЕРИОДИЧЕСКОЙ РЕАКЦИИ МАКА

I. Экспериментальное разграничение типов фотопериодической реакции

А. АНДРАШФАЛВИ

В сортовой коллекции (50 сортов) один заметно рано цветущий сорт в опытах по срокам посева и в опытах по фотопериодизму оказался безразличным в отношении длины дня. Остальные сорта коллекции в зависимости от места происхождения были различной скороспелости, но все были количественно длиннодневного характера. Сроки цветения в весеннем посеве связаны с потребностью в критическом индуктивном фотопериодическом воздействии. Длина критического фотопериода и число циклов, необходимых для индукции меняется в известной мере и в зависимости от возраста растения и от температуры. Фотопериодическая реакция сортов, приспособленных к озимым посевам более сильно выражена, чем у сортов весенних сроков посева. Это проявляется в усиленной фотопериодической реакции молодых растений и в существенной мере не сокращается и у более взрослых растений.

ИССЛЕДОВАНИЕ ОБРАЗОВАНИЯ РИЗОСФЕРНОЙ МИКРОФЛОРЫ НА КОРНЯХ ПРОРОСТКОВ САХАРНОЙ СВЕКЛЫ И В ИХ ОКРУЖЕНИИ

П. ДЮРКО

С помощью метода почвенной пластинки Rossi—Cholodny изучались таллом и количество бактерий на корнях проростков сахарной свеклы, проросшей из семян 1) зараженных и 2) незараженных ризосферными бактериями, и в их окружении в нестерильной почве. Влияние заражения на корнях 2х-недельных растений еще ясно можно было обнаружить. В окружении корней была определена та граница, до которой выделения корней влияют на количество микроорганизмов. Площадь в пределах этой границы в почве рассматривается как ризосфера. Сделаны квантитативные определения относительно распределения бактерий внутри ризосферы и в местах ее распространения на глубине частей корней различного возраста.

ДАННЫЕ ОТНОСИТЕЛЬНО ВОЗМОЖНОСТИ БОРЬБЫ С ВИРУСАМИ КАРТОФЕЛЯ

IV. Опыты по летним посадкам

Й. ХОРВАТ

Автор в предыдущих сообщениях (Хорват 1966 а, б, в) и в этом заключительном сообщении занимался агротехническими вопросами, уже десятилетиями известными в борьбе с вирусами картофеля, но относительно эффективности которых данные литературы все еще противоречивы. В процессе работы были установлены зараженность вирусами отдельных сортов картофеля, распространенных у нас в производстве, их средняя урожайность, содержание воды и сухих веществ, крахмальность, содержание витамина С и сахара. Рассматривались и вопросы биологии лета листовых тлей-векторов вирусов, а также и вопросы лежкости отдельных сортов картофеля. В результате сопоставления отдельных агротехнических приемов (немецкий метод, улучшенный немецкий метод, голландский метод, метод летних посадок) выяснилось, что показатель зараженности вирусами подопытных сортов картофеля (исходный материал) в среднем по сортам снизился по сравнению с данными 1961 года. Лучшие результаты были получены голландским методом (Км), если удаление ботвы производилось до лета векторов.

ПРОБЛЕМЫ ФИЗИОЛОГИИ РАЗВИТИЯ В ДЕЛЕ ВЫВЕДЕНИЯ ВЫСОКОУРОЖАЙНЫХ, СКОРОСПЕЛЫХ И ЗИМОСТОЙКИХ СОРТОВ ПШЕНИЦЫ

Л. БАЛЛА

Изучалось развитие ряда венгерских, западноевропейских и советских сортоя пшеницы, а также и их гибридов в условиях различной продолжительности светового дня. Часть венгерских и западноевропейских образцов и сорт Мироновская 808 сильно реагировали на сокращение светового дня. Сан Пасторе и Скороспелка 3б почти не реагировали, а Безостая 1 и Этоаль де Шоази заняли промежуточное положение между этими группами. Гибриды оказались более близкими к менее отзывчивому родителю.

ИССЛЕДОВАНИЕ РАЗВИТИЯ КОРНЕВОЙ СИСТЕМЫ ЯБЛОНИ ЙОНАТАН ПРИВИТОЙ НА ПОДВОЙ М—IV

Я. ТАМАШИ

В данной статье сообщается о развитии корневой системы яблони Йонатан, привитой на подвой М—IV. В опыте изучались деревья с низким штамбом и особой формировкой кроны, при которой ветви направлялись и закреплялись в гориозштальном положении. Опытные деревья были в возрасте от 1 года до 6 лет, в каждой возрастной группе изучалось по 9 деревьев. Подопытные деревья были выделены в крупном плодовом хозяйстве с песчаной почвой, где применялась выработанная там агротехника. На основании исследований установлено, что применявшаяся до сих пор система удобрения не способствовала соответствующим образом развитию корней как по годам, так и по распространению на площади.

ИЗУЧЕНИЕ ГИБРИДОВ ПЕРВОГО ПОКОЛЕНИЯ ОТ СКРЕЩИВАНИЯ AEGILOPS CYLINDRICA HOST X TRITICUM AESTIVUM L.

А. БЕЛЕА

Изучались морфологические и другие особенности, а также и условия фертильности гибридов, полученных скрещиванием различных сортов ***Aegilops cylindrica*** **Host.** и ***T. aestivum*** **L.** Скрещивания этих двух видов оказались достаточно успешными. Растения первого поколения выравнены и в отношении большинства морфологических признаков оказались промежуточными между родителями.

ВЛИЯНИЕ ПОГОДНЫХ ФАКТОРОВ НА РАЗВИТИЕ И ВСХОЖЕСТЬ ЗЕРНА ОЗИМОГО ЯЧМЕНЯ

Э. ПАПП

Многолетние данные свидетельствуют о тесной зависимости развития озимого ячменя и урожайности его от условий погоды в период вегетации (Манди 1965). Удалось выявить существенное влияние погоды как на вегетативное, так и на генеративное развитие озимого ячменя (Манди—Ковач 1963, Манди 1965). Казалось вероятным, что такое влияние проявляется и в период развития зерна и повлияет на биологическую ценность посевного материала. С целью более подробного выяснения этого вопроса с некоторыми сортами ячменя проводились детальные анализы. Использовался материал экологического опыта озимого ячменя 1964/65 г.

ИССЛЕДОВАНИЕ ПЕРМАНЕНТНОЙ ЦЕНОЛОГИИ В СВЯЗИ С ИЗМЕНЯЮЩИМ ФЛОРУ ВЛИЯНИЕМ ХИМИЧЕСКОЙ ПРОПОЛКИ

Г. УБРИЖИ

Исследования подтверждают значительное гормональное, контактное и многостороннее влияние корневых гербицидов на возможность изменения и на действительное преобразование антропогенной растительности. Распространение методов химической прополки по стране (в настоящее время ее проводят на площади 2 млн. кат. х.) и большая изменчивость при распространении по культурам и по местам произрастания (рис, овощные культуры и т. д.) будет иметь такое последствие, что флора сорных растений на пашне (в первую очередь облигатные и археофитонные сорняки) будет целиком изменена. Кроме изменения флоры можно ожидать также модификации ценологии сорняков. На паровых участках сукцессию можно ускорить, и путем размножения растений из Graminea удалось создать искусственным вмешательством более ценный состав растений. На пастбищах под влиянием химической прополки изменение растительности происходит наболее интенсивно. С точки зрения практики это полезно, т. к. связано с накоплением огромной массы кормовых трав и уничтожением вредных сорняков. Кроме того, опыты показывают, что теперь вопрос сорняков можно изучать только в разрезе ценологии, и когда выделяется участок для химической прополки, тогда это является борьбой не только в одной культуре данного сезона, но и борьбой против ценологии сорняков в целом. Борьбу против сорняков мы начинаем во всех культурах, которые позволяют применение чрезвычайных, радикальных химических методов. Я уверен, что в прикладной фитоценологии, за исключением территорий, исследуемых в связи с насаждением леса, ценология сорняков это студия, которая непосредственно и больше всего оказывает помощи широкому кругу сельскохозяйственной практики!

ВЛИЯНИЕ ПЕРЕМЕННОГО КОРМЛЕНИЯ МОЛОДЫХ СВИНЕЙ КОРМОМ БЕДНЫМ И БОГАТЫМ БЕЛКОМ НА ПРИБАВКУ В ВЕСЕ И НА ИЗМЕНЕНИЕ СОСТАВА БЕЛКА В СЫВОРОТКЕ

Л. ПЕНЗЕШ

Авторы изучали влияние переменного кормления выбранной группы свиней кормом бедным и богатым белком на прибавку в весе, использование корма и на изменение количественного состава некоторых белков в сыворотке.

В течение опыта, продолжавшегося 140 дней, прибавка в весе у контрольных животных была большей, чем у подопытных особей. Во второй половине опыта, в период дачи корма бедного белком с пользой можно было применять в качестве корма сушеные куски сахарной свеклы. В различные периоды опыта подопытные животные не показывали характерного использования корма, что определялось по проценту использования крахмальных единиц корма. На 1 кг привеса использованное количество переваримого белка в среднем было на 30% меньше в период кормления кормом бедным белком, чем у контрольных животных. В период кормления кормом богатым белком использование белков в значительной степени снижалось (примерно на 24%). Наблюдавшийся в некоторые периоды привес находился в связи с квантитативными изменениями состава белка в сыворотке.

МУТАНТ С НИЗКОЙ СОЛОМОЙ, ПОЛУЧЕННЫЙ ПРИ ОБЛУЧЕНИИ ГАММА ЛУЧАМИ ОЗИМОЙ ПШЕНИЦЫ КАРЦАГИ 522

П. ВИГЛАШИ

Осенью 1962 г. сухие зерна озимой пшеницы Карцаги 522 были обработаны гамма лучами Co^{60}. Применены дозы облучения в размере: 20 000, 25 000 и 30 000 R. Цель — получение мутанта с прочной и низкой соломой, а, именно, с соломой ниже оригинального материала, высота которого была 120—125 см. В поколении X_3 получены три растения с высотой 50—60 см, из которых в 1965 г. в поколении X_5 отобраны стабильные мутантные штаммы высотой в 70 см. Устойчивость против ржавчины у них лучше, чем у оригинального материала.

ИЗУЧЕНИЕ ТЕРПЕНОВ В ВЕГЕТАТИВНЫХ И ГЕНЕРАТИВНЫХ ОРГАНАХ РАСТЕНИЙ У CORIANDRUM SATIVUM L.

Ж. ЛАШШАНИ, К. ЛЕРИНЦ

Исследование линалоола и альдегидов методом тонкослойной хроматографии и гистохимический анализ

В своих исследованиях мы проводили гистохимические анализы и изучение методом тонкослойной хроматографии в течение онтогенетического развития растений — на сорте «Луч».

В гистохимических анализах мы использовали -2,4 dinitro-fenilhidrazin. На тонкослойной хроматографии мы анализировали эфирное масло, полученное методом дестиляции из свежих растений.

Эфирное масло частично анализировали квалитативно (Stahl, 1962, Леринц—Тихак 1965), частично квантитативно (Lassányi, 1965).

Определили, что в вегетативных органах растений и эфирное масло периферических вместилищ содержит больше альдегидов, а эфирное масло, с содержанием линалоола образуется только во внутренних вместилищах плодов. Одновременно определили, что с развитием плодов содержание линалоола повышается, в начале более резко, потом замедляется и наконец достигает постоянного уровня.

Во время созревания плодов эфирное масло из периферических вместилищ исчезает и не дает больше реакции на альдегиды. В созревших плодах только во внутренних вместилищах находится эфирное масло, богатое спиртами (линалоолом).

ВЛИЯНИЕ ПРЕДВАРИТЕЛЬНОЙ ТЕРМИЧЕСКОЙ ОБРАБОТКИ И АНАЭРОБНОЙ ГИДРАТАЦИИ НА ЧУВСТВИТЕЛЬНОСТЬ ГОРОХА К Х-ЛУЧАМ

А. БАЛИНТ, А. МЕХАНДЖИЕВ, Й. ШУТКА

С целью изучения возможностей направления мутационного процесса воздушно-сухие семена овощного гороха сорта Пети Провансал выдерживались в течение суток в сушильном шкафу при температуре в 60 $\pm$ 1 °С, а затем подвергались обработке рентгеновскими лучами с дозами в 8000 r и 11 000 r. После облучения проводилась анаэробная гидратация при температуре 50 $\pm$ 1 °С. Предварительное прогревание и анаэробная гидратация после обработки повышали относительную всхожесть и увеличивали среднюю длину проростков. Указанные условия сократили частоту хромосомных мостов и фрагментов в анафазе у митотических клеток. В результате совместного действия двух дополнительных факторов при дозе в 11 000 рентгенов было выявлено меньше хромосомных аберраций, чем в варианте с дозой 8000 рентгенов, но без влияния дополнительных факторов.

ИЗУЧЕНИЕ КОРРЕЛЯЦИЙ МЕЖДУ ЖИВЫМ ВЕСОМ, АБСОЛЮТНОЙ И ОТНОСИТЕЛЬНОЙ МОЛОЧНОЙ ПРОДУКТИВНОСТЬЮ КОРОВ ДАТСКОЙ КРАСНОЙ ПОРОДЫ

Я. ДОХИ, Г. КЕЛЕМЕРИ

Авторами, на основе данных 485 первотелок датской красной породы, проверяющихся в датской централизованной оценке по потомству, изучались корреляции между живым весом коров и абсолютной и относительной их молочной продуктивностью. Возраст животных при первом отеле колебался в пределах от 900 до 960 дней. Коэффициент корреляции между живым весом после отела и абсолютной продуктивностью за лактацию составил r = Ц + 0,213, между живым весом и относительной (в рассчете на 100 кг живого веса) молочной продуктивностью r = — 0,253, а между абсолютной и относительной молочной продуктивностью r = + 0,832. Корреляции были статистически достоверными. На основе своих данных и литературных мнений авторами предлагается включение относительной молочной продуктивности в группу селекционных показателей молочного скота.

О НЕКОТОРЫХ МАРТОНВАШАРСКИХ ИССЛЕДОВАНИЯХ ПО ПШЕНИЦЕ

Ш. РАЙКИ

Две темы, генетика превращения яровой пшеницы в озимую и биохимия яровизации, из четырех тем доклада, сделанного на краснодарском симпозиуме по селекции пшеницы, включены в данную публикацию, где излагается связь и взаимовлияние исследований, проводившихся свыше десяти лет по двум названным темам.

NOS · REDACTORES
ACTORVM · AGRONOMICORVM
ACADEMIAE · SCIENTIARVM · HVNGARICAE
INSTITVTO · AGRONOMICO · PETRO-GROZANO

CENTENARIVM
ACADEMIAE · AGRONOMICAE · CLAVDIOPOLITANAE
FVNDATAE
CELEBRANTI

IN · AGRONOMIS · EDVCANDIS · ERVDIENDIS · QVE
OMNIA · BONA · FELICIA · FAVSTA · FORTVNATA · QVE
EXOPTANTES

SALVTEM · PLVRIMAM · DICIMVS

DATVM · IN · VRBE · HVNGARORVM · BVDAPEST
MENSE · IANVARIO · ANNI · MCMLXVIII

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 3—12 (1968)

THE CYTOLOGICAL INDEXES OF ROOT GROWTH

II. CHANGES OF THE CELLS AND THEIR SUBSTANCE CONTENTS IN THE APICAL SEGMENT OF THE ROOT

By

M. MARÓTI

DEPARTMENT OF PLANT PHYSIOLOGY AND THE ALSÓGÖD BIOLOGICAL STATION OF THE L. EÖTVÖS UNIVERSITY, BUDAPEST

The author has examined, in 1 mm apical root segments of maize seedlings, the rhythm of growth, the evolution of cell population, as well as the changes of NA—P and protein-N contents, taken as a function of time. He has pointed out that the growth of root segments is caused to a minor extent by cell division and chiefly by cell expansion. The division is confined to the apical part from 0.50 to 2.50 mm. The highest intensity of mitosis takes presumably place between 1.25 and 2.25 mm. Cell expansion commences after about 3 hours subsequently to division and is indicated by appr. 100 per cent increase of cell substances. Cell expansion is closely connected with the changes of the contents and proportion of NA—P and protein-N in the cells. The differentiation of cells occurs in the 7th or 8th hour of incubation, 5 to 6 mm apart from the apex. The effect of light on root segment growth manifests itself in the stimulation of cell division.

Introduction

On the development of plant cells many valuable results are available (HEYES—BROWN 1965, STANGE 1965, TORREY 1965), but for the elucidation of the development inducing reasons and their effect mechanism still a great deal of research work is needed (BROWN 1963). Therefore, in the course of analysing the development of cells the connection between the growth rhythm and substance contents of cells has also been examined, because any developmental stage of the cell is undoubtedly connected with the metabolic situation characteristic of the developmental stage. In previous investigations (MARÓTI 1966, 1967) the growth rhythm and the changes of substance contents in 1 mm segments of the root apex containing different cell populations were compared. This paper reports on the developmental rhythm, contents and changes of metabolic indexes in the cell population of the apical 1 mm segment examined as the function of incubation time.

Material and Method

As experimental material the hybrid maize (*Zea mays* L) Mv_1 was taken and prepared in the same way as described in previous works (MARÓTI 1966, 1967). Only selected seedlings of uniform growth were used. After marking the apical 1 mm piece of the root with China waterproof ink, the seedlings were singly fixed with broad rubber rings to slides of 1 mm engraving. The preparations were put in glass cells (so-called cuvettes) and covered, so that the roots found contact with distilled water. The glass cells were placed in a thermostat at 28 (± 1)°C temperature. The growth of the marked apical root segment was registered hourly in red light, on the mm etching of the slide by the aid of a magnifier. The growth intensity of apical root segments was established from a large material satisfying also the requirements of statistical analyses (SNEDECOR 1956). The pieces indicating the hourly increment were thoroughly examined, and from these results as well as from other ones achieved in experiments with the same material under similar conditions the data of cell weight, cell number, NA—P and protein-N contents were calculated (MARÓTI 1966, 1967). The number of cells was established with the method of BROWN (1951), the values of NA—P were determined according to OGUR—ROSEN (1950) while those of protein-N according to KELLEY *et al.* (1946) and to THOMPSON—STEWARD (1952). The measurement of NA—P and N was carried out with a photometer of the type Spektromom 360. All data were also calculated for one cell. The proportions of protein-N and RNA—P were determined from the absolute values of the analyses.

Results

The absolute data of analyses and the converted values are presented in Tables 1 to 3 and in Figs 1 and 2.

The experimental results demonstrate that at the start the growth of the 1 mm segment is very slow: it amounts only to 0.06 mm in the first hour, that is merely a 6 per cent increment of the original length. This growth rhythm is explained by the fact that most cells consist of differentiated calyptra cells and, besides, this apical part of the segment is the place of the supposed "quiescent centre", the cells of which do not divide at all or show a very slow division. Therefore, a dividing cell population can be found only in the basal part of the mm segment. During the second hour the disk became 1.52 mm long, increasing thus by about half of its initial length. So in the first two hours the segment showed an increase of 52 per cent. In the third hour already a considerable growth took place, amounting to 128 per cent of the original length, i.e. the root piece came up to 2.28 mm. In this portion — exactly between the 1st and 2nd mm from the apex — the intensively growing zone had already developed and by this the root piece reached its maximum growth per unit of time i.e. elongating by about 1 mm hourly. This rate continued to remain from the fourth hour onward till the end of the experiment. In the 10th to 11th hour an increment of 1.2 to 1.5 mm could be observed. Accordingly, the rhythm of growth developed after the first 3 hours, reaching a high degree during this time and becoming uniform after four hours. This is demonstrated clearly in Table 1 by the absolute values (hourly rate) of elongation and the percentual data expressing the whole growth.

The values of fresh weight of the examined root segment showed proportions similar to those of length values. Also the weight reached the double of its initial value in the 3rd hour and from this time onward the root was increasing by the weight of about a 1 mm disk hourly, reaching the tenfold of the initial value after the 11th hour. From the weight data it may be concluded that from the 3rd mm the root is of identical thickness, as an elongation of 1 mm corresponds to a weight increase of 0.800 to 0.900 mg. The dry weight

Table 1

Changes of length, weight and cell number in the 1 mm apical segment of maize root

($\bar{x}$ = mean value; s = standard deviation; D_s = significance)

Incubation time, hours	Length (mm)					Fresh weight* (mg)			Cell number* (piece × 10^3)			Dry weight in per cent of fresh weight
	Total growth			Increment		Total	Increment		Total	Increment		
	$\bar{x}$	s	D_s	$\bar{x}$	%	$\bar{x}$	$\bar{x}$	%	$\bar{x}$	$\bar{x}$	%	
0	1.00	—	—	—	—	0.84	—	—	79.0	—	—	8.77
1	1.06	0.02	3.0	0.06	6	0.88	0.04	5	83.2	4.02	5	9.01
2	1.52	0.12	3.2	0.46	52	1.24	0.36	46	105.6	22.4	33	10.33
3	2.28	0.12	3.1	0.76	128	1.84	0.60	118	160.1	54.5	102	11.07
4	3.28	0.21	3.0	1.00	228	2.67	0.83	217	192.2	32.1	143	10.76
5	4.28	0.12	3.0	1.00	328	3.39	0.72	303	208.2	16.0	163	10.47
6	5.38	0.20	3.4	1.10	438	4.31	0.92	411	223.7	15.5	183	9.94
7	6.38	0.12	3.1	1.00	538	5.12	0.81	508	234.1	10.4	196	9.49
8	7.58	0.30	2.7	1.20	658	6.17	1.05	632	244.9	10.8	210	8.96
9	8.58	0.02	3.1	1.00	758	7.07	0.90	739	252.2	7.3	219	8.57
10	9.78	0.24	4.6	1.20	878	8.20	1.13	873	258.9	6.7	227	8.24
11	11.28	0.24	3.1	1.50	1028	9.68	1.48	1049	265.7	6.8	236	7.94

* Calculated values

in terms of fresh weight percentage fluctuated generally between 8 and 11 per cent, showing its minimum at the apex, which may clearly be understood from the cell composition of the disk. Subsequently, the value increased and reached its maximum (11 per cent) during the 3rd hour corresponding to the part between the 2nd and 3rd mm. Hereupon the weight gradually diminished indicating the increased hydratation.

The cell number doubled after the third hour as well. After the first hour a very small increase of only 5 per cent could be observed. This reveals that the apical segment contains only few dividing cells and chiefly consists of differentiated calyptra tissue and of resting cells fit to differentiate. From literature data it is known that at the experimental temperature the frequency of mitosis is low and the mitosis cycle takes about one hour, so it can be concluded that in the first hour only about 5 per cent of the cells divided. This value increased to 25 per cent in the 2nd hour, not so much as a consequence of temperature, but rather due to the fact that in the part toward the base more and more cells were obtaining access to the dividing region and, therefore, the number of cells increased by 33 per cent in relation to the initial value. In the 3rd hour the half of all cells, having been developed in the previous time (105.6×10^3), divided, and so their number increased by 54.5×10^3, amounting thus to the double of the initial value and representing a 102 per cent augmentation.

Table 2

Increase of NA—P and protein-N in the 1 mm apical segment of maize root

Incubation time, hours	RNA—P* (μg)			DNA—P* (μg)			Protein-N* (μg)			Protein-N / RNA—P
	Total	Increment		Total	Increment		Total	Increment		
	$\bar{x}$	$\bar{x}$	%	$\bar{x}$	$\bar{x}$	%	$\bar{x}$	$\bar{x}$	%	
0	0.41	—	—	0.34	—	—	4.61	—	—	11.03
1	0.44	0.02	5	0.35	0.01	4	4.87	0.26	5	11.07
2	0.60	0.16	45	0.47	0.12	39	6.89	2.02	49	11.32
3	0.87	0.26	109	0.66	0.18	93	10.01	3.11	117	11.44
4	1.21	0.33	190	0.86	0.20	154	13.99	3.98	203	11.53
5	1.55	0.34	272	1.06	0.19	210	17.41	3.41	277	11.16
6	1.92	0.36	361	1.26	0.20	270	21.23	3.82	360	11.01
7	2.28	0.36	446	1.41	0.15	314	25.00	3.78	442	10.94
8	2.65	0.37	535	1.59	0.18	368	28.80	3.80	524	10.84
9	2.88	0.23	590	1.75	0.15	414	31.76	2.96	588	11.00
10	3.08	0.20	638	1.90	0.14	458	35.39	3.62	667	11.46
11	3.25	0.17	678	1.99	0.08	483	37.32	1.93	709	11.47

* Calculated values

Here, in this root part, is the maximum of cell division. Once the first 3 hours passed the increase per hour successively diminishes: from the 4th till the end of the 11th hour the hourly rise is dropping from 32.1×10^3 to 6.8×10^3. Though in the total quantity an increase manifests itself, from the 4th till the 11th hour the increase of cell number is only 134, i.e. altogether 236 per cent.

The changes of the NA—P and protein-N contents in the apical segment of the root are shown in Table 2. The augmentation of RNA—P revealed a slow commencement as well: it doubled in the 3rd hour and reached nearly the eightfold value at the end of the experiment. From the 4th till the 8th hour the hourly increase was roughly of identical quantity (0.338 to 0.371 μg), and, in the last 3 hours, diminished successively to the half. Accordingly, the first 3 hours represent the time of slow, gradually rising augmentation similar to the data of length and weight. The hourly rhythm of DNA—P showed an analogous trend. Its quantity and accumulation rhythm was always lower than that of RNA—P; this is demonstrated clearly by the percentual data of increase, indicating that till the end of the experiment the quantity of DNA—P has increased only to about the sixfold of its initial value in the root piece. The changes of protein-N followed those of RNA—P both in proportion and in rhythm. Its quantity was elevenfold larger — as displayed well by the protein-N/RNA—P ratio, having fluctuated between 10.84 and 11.53 during the whole

Table 3

Changes of weight, NA—P and protein-N content per cell in the 1 mm apical segment of maize root

Incubation time, hours	Fresh weight/cell ($\mu g \times 10^{-3}$) in the		RNA—P/cell ($\mu g \times 10^{-6}$) in the		DNA—P/cell ($\mu g \times 10^{-6}$) in the		Protein-N/cell ($\mu g \times 10^{-5}$) in the	
	segment	increment	segment	increment	segment	increment	segment	increment
0	10.67	—	5.29	—	4.31	—	5.83	—
1	10.67	10.71	5.28	5.23	4.27	3.57	5.85	6.26
2	11.73	15.66	5.76	5.54	4.50	5.35	6.53	9.02
3	11.50	12.90	5.46	4.88	4.12	3.37	6.25	5.71
4	13.91	25.95	6.31	10.52	4.51	6.44	7.25	12.40
5	16.32	45.25	7.48	21,62	5.09	12.06	8.36	21.33
6	19.27	58.90	8.61	23.74	5.64	13.03	9.49	24.67
7	21.90	76.44	9.76	34.42	6.03	14.52	10.68	36.42
8	25.22	97.31	10.84	34.35	6.52	17.13	11.76	35.19
9	28.05	122.87	11.43	31.36	6.95	21.50	12.59	40.54
10	31.68	168.35	11.91	30.00	7.35	22.23	13.66	54.13
11	36.46	218.52	12.24	24.55	7.48	12.64	14.04	28.52

experiment. So, the hourly changes of NA—P and protein-N followed clearly the longitudinal growth and weight increase of the root segment.

The per cell values of hourly increments of the root segment are summarized in Table 3. The first column in each section shows the values related to all cells of the whole root piece, whereas in the second column the data of increase, i.e. that of the hourly surplus material are presented. This latter gives a picture approaching reality, which is proved by the fact that analysing the 1 mm zones of the root, similar cell weights have been found with increasing distance from the apex (MARÓTI 1966).

The results also reveal that the weight of cells is increasing in the first 3 hours, doubles in the fourth and shows an about twentyfold value at the end of the experiment. The increase of NA—P and protein-N in the cell shows just as well a slow start and comes up to a 100 per cent plus in 4 hours. The maximum was reached by RNA—P in the 6th, by DNA—P and protein-N in the 10th hour showing a six- to eightfold concentration in comparison to the initial stage, but the accumulation dropped to a four- or fivefold value till the end of the experiment. So, after a decisive maximum, a certain decrease of their quantity in the cell could be observed. Because the increase of the fresh weight is of a much higher degree than the change of these latter indexes, a considerable vacuolization occurring in the 7th to 8th hour must be supposed between the 6th and 7th mm under the given experimental conditions (Figs 1 and 2).

The experiment was also repeated in light, so that the seedlings might obtain natural sunlight through the glass door of the thermostat. This treatment should clarify the effect of light presumably modifying growth and differentiation. Among the results of both experiments hardly any essential difference could be found. The proportion of substance augmentation is of very similar pattern. Comparing the corresponding incubation times, however, it turned out

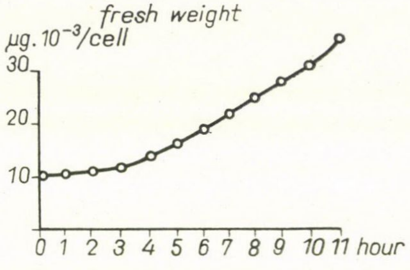


Fig. 1. Changes of weight in the apical segment of maize root. Ordinate: Fresh weight/cell. Abscissa: Incubation time

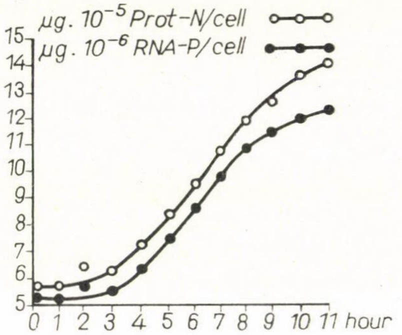


Fig. 2. Changes of protein-N and RNA—P contents of cells in the apical segment of maize root. Ordinate: Protein-N/cell and RNA—P/cell. Abscissa: Incubation time

that at the beginning of root segment growth (length, weight, cell number) certain differences appeared. Under the influence of light a considerable increment of 21 to 28 per cent occurred as early as in the first hour, whereas it amounted only to 4—6 per cent in darkness. The increase was more favourable under light even in the 2nd hour while in the 3rd hour differences were being levelled up. That was the time when the doubling of initial values occurred also here. The other perceptible difference manifested itself in a more uniform rate of the longitudinal and weight increase in light than in darkness. Accordingly, light affects only the initial stages of root growth, which effect — however — expires later. The weight of cells, their NA—P and protein-N quantity are not observably influenced by the light.

Discussion

The experimental series reported here aimed at elucidating the developmental time and rhythm of the apical segment of the root and its cells. Both previous results of the author (MARÓTI 1966, 1967), and literature data (BALDOVINOS 1953; ERICKSON—GODDARD 1951; TORREY 1965; WOODSTOCK—SKOOG 1960, 1962) reveal that the values obtained are reasonable. The data of standard deviation and significance calculated for the values of length show clearly that partly the measured results are fairly uniform and partly the hourly differences significantly deviate from one another.

Reviewing experimental results it turns out that the analysis of the 1 mm apical segment of the root yields important data on the trend of cell development. From these it was established that root growth was caused to a minor extent by the division of cells but chiefly by their elongation and expansion. The division showed an increasing trend in the first 3 hours of incubation and occurred mostly in the section from 0.5 to 2.5 mm. The place of maximum division speed was approximately the part between 1.25 to 2.25 mm and took appr. 2 hours. But in the new cells an immediate expansion took place as well. After reaching the 2.5 mm length the root part continued to grow uniformly and its development was rather due to cell elongation and expansion of fairly uniform degree. This implication is confirmed by investigations carried out by other authors on maize, chiefly by the results of BALDOVINOS (1953), ERICKSON—GODDARD (1951), WOODSTOCK—SKOOG (1960, 1962) as well as by the summaries of STANGE (1965), TORREY (1965) and WHALEY (1961). The proportions of division and expansion as components of growth are demonstrated clearly above all in the Tables 1 to 3. Cell expansion playing a greater role in root growth is proved by the fact that the increase of cell number lags behind the rhythm of elongation especially in percentual values. This becomes entirely conspicuous after the 4th hour. Accordingly, from this moment the division has only a very small part in root growth. Similarly it can be stated that out of cell augmentation no conclusion can in this material be drawn as to the rhythm of mitoses.

Neither can we conclude from the data to the general validity of the division of vacuolized cells observed by SINNOTT (1960). The values of dry matter in terms of fresh weight per cent are highest after the 3rd hour, indicating that the cell population contains the minimum quantity of water and, therefore, no considerable vacuolization takes place at this time. Topographically this corresponds to the part from 2.0 to 2.5 mm. The lower values before this spot are due partly to the vacuolized calyptra cells and partly to the undeveloped cell walls. After the 4th hour the proportion of the dry weight gradually decreases indicating the commencement of vacuolization. On the other hand, the number of cell divisions has by this time diminished, which is also demonstrated by a very small increase of cells. The latter phenomenon can probably be traced back to the activity of the cambium organizing the vascular vessels of the root. Accordingly, in maize the division of vacuolized cells can be only of a small extent or it does not occur at all. The temporal vacuolization of root segments is clearly demonstrated also by the so-called hydration value, amounting to 8.0 after the 3rd hour of incubation and to 11.6 after the 11th hour; its initial value — at 0 o'clock — was 10.4. [The hydratation value was calculated — according to BALDOVINOS (1953) — as the quotient obtained by relating the difference of fresh and dry weight to the dry weight.]

In the literature also the role of light causing cell division and expansion in the root is mentioned (BUTCHER—STREET 1964), though an opposite effect was as well observed in wheat root (BJÖRN *et al.* 1963). Its growth increasing role is brought into connection with the effect exerted on the permeability of the cell membrane. The growth stimulating influence was also observed by DE CAPITE (1955) in tissue cultures. In the experiments of the present author the stimulating effect of light manifested itself at the time of cell division, from 0 o'clock to the 3rd hour. The differences between the roots kept in darkness and light became balanced later. So, according to observations of the author light influences rather the division than the expansion of cells; this tallies with the results of DE CAPITE. By HUMPHRIES—WHEELER (1960) the division and cell increasing effect of light were also observed in bean leaves.

The most important result of the experiments is that between the condition of cells and their NA—P and protein-N content a decisive connection can be found. So it turned out that after the 3rd hour the RNA—P, DNA—P and protein-N contents of cells increased considerably, by about 100 per cent. At this time in the cells not only division but a great deal of expansion takes place, resulting in a total length of 1.25 to 2.50 mm. From this time the number of dividing cells remains constant, but their proportion successively diminishes in comparison to the number of expanding, differentiating cells. This manifests itself also in the amount of NA—P and protein-N — obtained by measurements on the root piece and by calculation respectively —, and still in the per cell quantities. Accordingly, the commencement of cell elongation and expansion can clearly be registered in the quantitative changes of these substances. In reality, the contrary is true, because, as it is known, the morphological changes of cells are induced by the quantity and proportion of these substances. Therefore, on the basis of the experiments the direct connection and parallelism between the condition and substance quantity of cells may be considered as verified. This conclusion can be confirmed by many data. WOODSTOCK—SKOOG (1960, 1962) assume direct connection between the growth and the RNA—P contents of root cells in maize. According to IVANOV (1961) the correlation between the RNA and protein contents and their proportion on the one hand and the condition of root cells in maize, on the other, grow with increasing distance from the apex in accordance with the intensified division and expansion. CHERRY—HAGEMAN (1961) observed also the augmentation of both compounds mentioned above in developing maize cells. The results achieved by HEYES—BROWN (1965), INGLE—HAGEMAN (1964), LEECH (1960) and OAKS (1963) in the examination of maize root cells corroborate those of the author and support the hypothesis that the condition of cells depends on their NA and protein-N contents.

Conclusions

Under the conditions of the experiments the root growth of maize seedlings consisted to a minor extent of cell division and chiefly of cell expansion. The divisions occurred in the apical section from 0.50 to 2.50 mm. Their maximum speed (the highest frequency of mitosis) took place in the root part from about 1.25 to 2.25 mm. The duration of the mitosis cycle was about 2 hours.

In vacuolized cells no division could be observed nor was the supposition as to the frequent occurrence of this phenomenon proved by changes in the cell number.

The effect of light on the growth of the root segment prevailed chiefly in the stimulation of cell division, and was observed in the first 3 hours of root incubation; later this effect became balanced.

Under the conditions of the experiments the cell expansion in the root began after 3 hours subsequently to division in the section from about 1.25 to 2.60 mm. The start of expansion was indicated by a substance augmentation of some 100 per cent. The expansion parallel with the synthesis could also be observed in the proportion changes of NA—P and protein-N quantities per cell. The so-called differentiation occurring in the 7th to 8th hour of incubation, at a distance of approximately 5 to 6 mm from the apex was connected only with a substance synthesis of low degree which was clearly indicated also by the dry weight decrease below 10 per cent.

Acknowledgement

For technical assistance in the experiments thanks are due to Mrs. Eszter H. NÁDASSY.

REFERENCES

BALDOVINOS DE LA PENA, G. (1953): Growth of the Root. In LOOMIS, W. E.: Growth and Differentiation in Plants. 27—54. Iowa State College Press, Ames.

BJÖRN, L. O.—SUZUKI, Y.—NILSSON, J. (1963): Influence of Wavelength on the Light Response of Excised Wheat Roots. Physiol. Plant., **16**, 132—141.

BROWN, R. (1963): Cellular Differentiation in the Root. Symp. Soc. Exp. Biol., **17**, 1—17.

BROWN, R. (1951): The Effects of Temperature on the Duration of the Different Stages of Cell Division in the Root Cells. J. Exp. Bot., **2**, 96—110.

BUTCHER, D. N.—STREET, H. E. (1964): Excised Root Culture. Bot. Rev., **30**, 513—586.

CHERRY, J. H.—HAGEMAN, R. H. (1961): Nucleotide and Ribonucleic Acid Metabolism of Corn Seedlings. Plant Physiol., **36**, 163—168.

DE CAPITE, L. (1955): Action of Light and Temperature on Growth of Plant Tissue Culture in vitro. Amer. J. Bot., **42**, 869—116.

ERICKSON, B. O.—GODDARD, D. R. (1951): An Analysis of Root Growth in Cellular and Biochemical Terms. Growth, **15**, Suppl. 89—116.

HEYES, J. K.—BROWN, R. (1965): Cytochemical Changes in Cell Growth and Differentiation in Plants. In RUHLAND, W.: Handbuch der Pflanzenphysiologie, **15/1**, 189—212. Springer, Berlin.

HUMPHRIES, E. C.—WHEELER, A. W. (1960): The effect of Kinetin, Gibberelline Acid and Light on Expansion and Cell Division in Leaf Disks of Dwarf Bean *(Phaseolus vulgaris)*. J. Expt. Bot., **11**, 81—85.

INGLE, J.—HAGEMAN, R. K. (1964): Studies of the Relationship between Ribonucleic Acid Content and of the Rate of Growth of Corn Roots. Plant Physiol., **39**, 730—734.

IVANOV, V. B. (Иванов, В. Б.) (1961): Цитохимическое изучение отношения РНК: белок в протоплазме растущих клеток корня. Ж. Общ. Биол., **22**, 100—117.

KELLEY, O. P.—HUNTER, A. S.—STERGERS, A. J. (1964): Determination of Nitrogen, Phosphorus, Potassium, Calcium and Magnesium in Plant Tissue. Ind. and Eng. Chem. Anal. Ed., **18**, 319—322.

LEECH, J. H. (1960): The Growth and Development of the Primary Root of *Zea mays*. Diss. Abstr., **21**, 1346. Michigan.

MARÓTI, M. (1966): A növényi sejtfejlődés kapcsolata anyagcseremutatókkal (Connection of Cellular Development in Plants with Metabolic Indexes). Diss., Budapest.

MARÓTI, M. (1967): A gyökér növekedésének sejttani mutatói. I. Intakt gyökércsúcs szegmentjeinek növekedése (The Cytological Indexes of Root Growth. I. The Growth of Intact Apical Root Segments). Annal. Univ. Sci. Budapest, Sec. Biol., **9** (In press).

OAKS, A. (1963): The Control of Amino Acid Synthesis in Maize Root Tips. Biochem. Biophys. Acta, **76**, 638—641.

OGUR, M.—ROSEN, G. (1950): The Nucleic Acids of Plant Tissue. I. Extraction and Estimation of Deoxypentose Nucleic Acid and Pentose Nucleic Acid. Arch. Biochem., **75**, 262—276.

SINNOTT, E. W. (1960): Plant Morphogenesis. MCGRAW-HILL, New York.

SNEDECOR, G. W. (1956): Statistical Methods Applied to Experiments in Agriculture and Biology. Iowa State College Press, Ames.

STANGE, L. (1965): Plant Cell Differentiation. Ann. Rev. Plant Physiol. **16**, 119—140.

THOMPSON, J. F.—STEWARD, F. C. (1952): The Analysis of the Alcohol Insoluble Nitrogen on Plants by Quantitative Procedures Based on Paper Chromatography. I. The Analysis of Certain Pure Proteins. J. Exp. Bot., **3**, 170.

TORREY, J. G. (1965): Physiological Bases Organization and Development in the Root. In RUHLAND, W.: Handbuch der Pflanzenphysiologie, **15/1**, Springer, Berlin. 1256—1289.

WHALEY, W. G. (1961): The Growth as a General Process. In RUHLAND, W.: Handbuch der Pflanzenphysiologie, **14**, Springer, Berlin. 71—112.

WOODSTOCK, L. W.—SKOOG, F. (1960): Relationships Between Growth Rates and Nucleic Acid Contents in the Roots of Inbred Lines of Corn. Amer. J. Bot., **47**, 713—716.

WOODSTOCK, L. W.—SKOOG, F. (1962): Distributions of Growth Nucleic Acids, and Nucleic Acid Synthesis in Seedling Roots of *Zea mays*. Amer. J. Bot., **49**, 623—633.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 13—24 (1968)

APPEARANCE OF SECTORIAL MATERIAL TRANSPORT DISORDER ON PRUNED FRUIT TREES

By

T. BRUNNER

DANUBE—TISZA MIDREGION AGRICULTURAL EXPERIMENTAL INSTITUTE
KECSKEMÉT

On the basis of mechanical water conductivity and calcium content examinations conducted in the region of the site of pruning and observing the development of the pullulating border of cicatrices caused by pruning, author establishes the disorder in material transport elicited by pruning to be of sectorial character and names the phenomenon "sectorial material transport disorder". The consequences of this sectorial material transport disorder elicited by the pruning are illustrated by the measurement of woundings caused by farmscale thinning-pruning conducted in a single year in a *Jonathan* orchard of bearing age.

Introduction

The new cultural practices developing in fruit production are based on omitting pruning as far as possible (PORPÁCZY *et al.* 1964; FEJES—HORN—BRUNNER 1966). In the development of the new trend (the shape of the fruit hedge and of the mode of cultivation) rather the immediate experience of the grower has played the prominent role so far while the disclosure of physiological causal connections is for the most part missing. This has promoted the formation of certain extreme standpoints which on the one side stood up for the unconditional use of the new agricultural technology while on the other side also complete negation and rejection have evolved.

The partisans of the new farm technology relied in the last resort on the results obtained while its opponents stressed the errors and the missing results. From both viewpoints, however, the physiological principle was absent starting from which valid statements could have been made as to whether the fault was in the method itself or only in the realization.

Already in our earlier work (BRUNNER 1965) in this connection we were led by the consideration, contemplating the results of the new fruit production technology to undertake the examination of the basic effects of pruning. The standpoint occupied in the question of pruning is the crucial point which separates the realizators of the old and new cultivation methods from each other.

Our results attained earlier and consequences drawn are presented as follows:

In the course of the examination of the direct effect of fruit-tree pruning it has been established that this interference causes defects in the vascular tissues (Fig. 1). In case of the varieties *Jonathan* and *Magyar kajszi* (apricot) the effect of pruning sites on the tissues was examined on 4—5-year-old branch parts as compared to the tissues of branch parts with apical bud sites of similar age. (That is: where further growth did not take place from the terminal bud

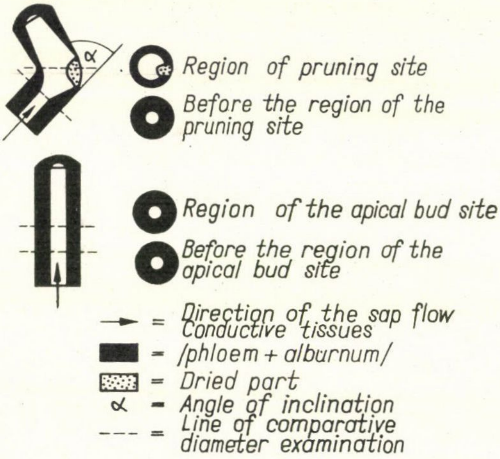


Fig. 1. Development of the active vascular tissues in the region of pruning site and apical bud site in radial and transversal sections. (In the case of apricot we refer to apical bud site region for simplicity's sake although the original apical bud is destroyed and its place is occupied by the lateral bud below. We are justified to do so because this natural physiological apical regeneration similarly to the further growth from the apical bud ensures material transport free of defect)

below the site of pruning according to the physiological regeneration of the apex bud from apical bud.) According to our examinations in *Jonathan* trees the site of pruning as related to the site of the apical bud means in radial section 31.94 per cent, in *Magyar kajszi* 45.93 per cent greater diminution of diameter in the vascular tissues (phloem + alburnum), at the same time in transversal section the site of pruning has caused as compared with the site of the apical bud a reduction of surface in the vascular tissues which was 16.45 per cent greater in *Jonathan* and 23.55 per cent in *Magyar kajszi*. — Moreover, we have examined, in the region of the site of pruning the development of the mechanical water conductivity under a pressure of 0.2 atm. In both fruit varieties we have found that under a given pressure the site of pruning diminished the water conductivity of the vascular tissues by 25 per cent on the average.

In this connection beside on apple and apricot examinations have been conducted also on peaches, cherries, sour cherries and pears. These partly numerically not yet evaluated and informatory preliminary examinations also testify that the fruit species generally suffer the defects demonstrated in *Jonathan* and *Magyar kajszi* under the influence of pruning.

In our further investigations to be discussed in the present paper we have tried to still more support the results presented above. In the course of this work, however, also quite new moments arose which disclosing the further physiological effects of fruit-tree pruning will be perhaps utilizable for the practice of growing to a greater extent.

Material and Method

Examinations were conducted on the material of the farm orchard in the laboratory of the Department of Fruit Growing of this Institute in Cegléd. The variety was *Jonathan;* the stock: wild stock; the shape of tree: middle high stem with branch group; soil: grassland; data of establishment: 1949; spacing 8 × 8 m.

Examination 1. — 4—5-year-old branch parts were cut off the trees. The 4-year part had come into being from the 5-year-old as a result of pruning on terminal bud. The site of pruning in the material of the examinations conducted in 12 fold replication had been almost completely healed. The 4-year-old part above and the 5-year-old part below the pruning site were cut off the tree in a length of 3 cm each and we thus obtained the about 6 cm long structure seen on Fig. 2. The structures described were connected to a metal plate developed to Y shape at the 4-year-old part so that at a depth of 2—3 mm the lower leg of the "Y plate" was deepened into the lower part of the material and so at the other end from the structure placed under 0.2 atm. water pressure separately departed from the 5 cu.cm water transmitted the part which could pass through the so-called "wounded sector" from the side of the pruning site and separately on the opposite side of the amount of water that went through the "unwounded sector". Since the "Y plate" naturally could not be placed exactly in the median plane therefore weighing separately the amount of water dropped through the two sectors we related it to the corresponding unit area of the lower transversal surface divided into two halves and expressed the difference in the water conductivity of the wounded and not wounded sector in cu.cm/sq.mm. Comparison was made with 12-fold replication.

Besides, we examined the difference in water conductivity between the wounded and not wounded sector similarly at the cicatrized pruning sites of lateral branches removed at the basis from 5-year-old branch parts.

Examination 2. — We gathered simultaneously from the same trees similar structures, and subsequently cut both the part above and below the site of pruning; the thus separated 4-year-old 3 cm long branch part above the site of pruning and the 5-year-old 3 cm long part below the site of pruning were cut in the radial plane also thus that the "wounded sector" from the side of the pruning site and the "not wounded sector" on the opposite side should be separated. In this way we obtained four different examination materials: wounded sector above the site of pruning, not wounded sector above the site of pruning, wounded sector below the site of pruning and not wounded sector below the site of pruning. As a control also 4—5-year-old parts with apical bud sites were removed from the trees and similarly cut into parts above and below the apical bud site but, as on these there was no pruning site of course, we halved these at random and marked the corresponding halves arranged opposite each other with "a" and "b". Thus we again obtained four groups of material, that of the sector "a" and "b" above the apical bud site and that of the "a" and "b" sector below the apical bud site (Fig. 3).

These 4 materials each both of the pruning site and of the apical bud site were taken always from 5 branches and those corresponding to each other chopped, dried out and ground, then homogenized. Thus our examinations for calcium content conducted with 6 replications contained within 1 replication 5 concealed replications, that is they supplied in reality the results of 6 × 5 = 30 replications. The percentual determination of the Ca-content related to the dry matter was carried out with the examination method of the Hungarian Standard MSZ 448-55/1962. The time of sampling was January 1966.

Beside the examinations connected with the non reutilizing calcium on the same material our examinations for total carbohydrate content and total nitrogen content gave such results of spreading, which indicated certain trends, but were essentially not suitable either to verify or to refute the disorder of material transport induced by the sites of pruning.

Since among the single structures of a fruit tree of great extent the stem, the various branch storeys and within these the structures of various order and age cause a high variety in the analytical contents which is still enhanced by the seasonal change (COUTANCEAU 1953), it is not possible to sieve out the modificatory and variability effect of these in the course of the examination of such small area as the parts above and below the site of pruning. Besides,

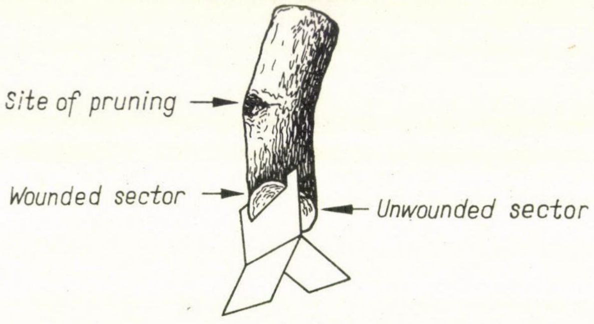


Fig. 2. Schematic drawing of sectorial mechanical water conductivity

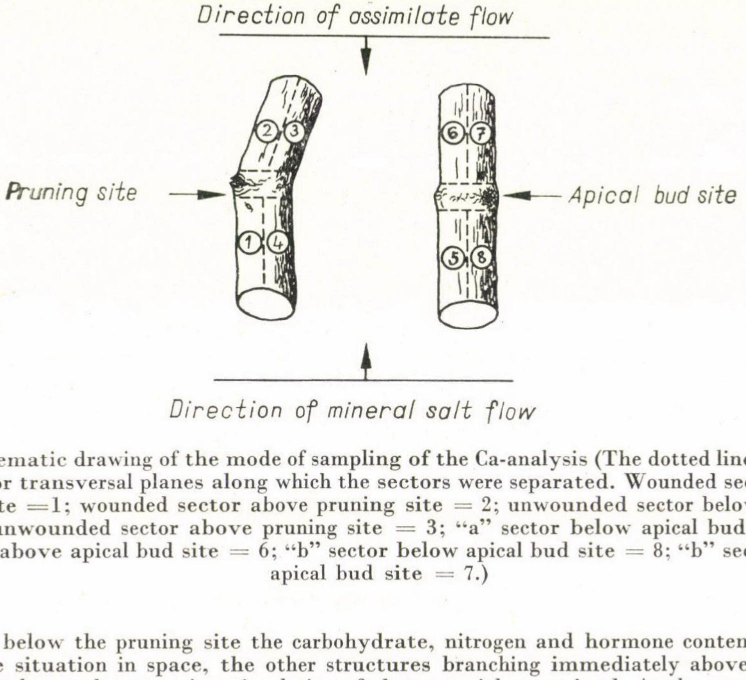


Fig. 3. Schematic drawing of the mode of sampling of the Ca-analysis (The dotted line indicates the radial or transversal planes along which the sectors were separated. Wounded sector below pruning site =1; wounded sector above pruning site = 2; unwounded sector below pruning site = 4; unwounded sector above pruning site = 3; "a" sector below apical bud site = 5; "a" sector above apical bud site = 6; "b" sector below apical bud site = 8; "b" sector above apical bud site = 7.)

above and below the pruning site the carbohydrate, nitrogen and hormone content depends also on the situation in space, the other structures branching immediately above or below and frequently on the extensive circulation of the materials examined. At the same time we refer to the examinations of FRENYÓ (1964—1966) who proved on herbaceous plants the quantitative nature of the uptake of material. On this analogy we assume that the connected material uptake and transport of the branch-, twig-, cane- and shoot parts of various order and the getting across through the defectuous places created by the dams of the pruning site and the changes of concentrations connected may take place quantitatively. As well viz., the statement of FRENYÓ connected with the motivation of the quantitative material uptake, according to which the living system shows some resistance to the environmental changes, may be valid also here. (In our case from the point of view of the branch part above the pruning site "environment" may be below the pruning site.) The external change according to FRENYÓ can overcome the inner resistance only when it has outgrown a certain threshold value.

Thus the analytical conditions on account of these various causes may cover the material transport disorder elicited by the pruning.

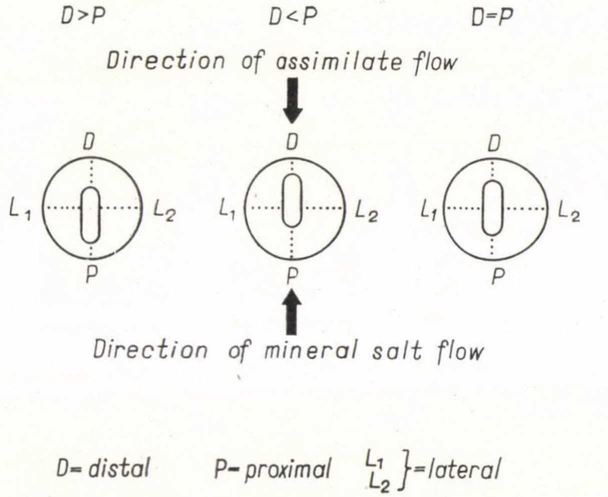


Fig. 4. Schematic drawing of the developments of the pullulating edge on the cicatrices caused by pruning

Calcium on the other hand, as non reutilizing element (FRENYÓ 1959) could supply us data characteristic of the site of pruning and of the site of the apical bud because it is flowing consistently upwards from below and it is not able to lateral translocation so that it necessarily accumulates below a certain dam and manifests its effect on the circulation of material.

Examination 3. — Beside the calcium content and the mechanical water conductivity, however, we have found a rather authentic physiological test to demonstrate the effect of pruning. This is the wound wood developing on the pullulating edge of the pruning sites.

It appears from Fig. 4 that the arch of the pruning wounds from the side of the basipetal organic substance stream taken schematically is marked with D (distal), the arch on the side of the ascending mineral substance stream with P (proximal) while the lateral arches binding the above two together obtained the mark L_1 and L_2. The diameters marked on the Figure with points of the wound wood arches D, P, L_1 and L_2 were measured and related to each other; thus we obtained a picture on what complex nutrient supply disorders the break caused by the wounding could have brought about in the case of the wound wood depending on the situation of the various arches.

Examination 4. — We attempted to bring into connection with the practice of cultivation the somewhat abstracted results of the three previous examinations by a farm-scale thinning-pruning examination conducted late in winter 1966. Therefore in the ***Jonathan*** orchard on wild stock on the Cegléd station of this Institute we carried out surveys on 18th February 1966 on 6 trees with medium high stems of bearing age and established how many cicatrices with what surface and periphery this farm-scale (not experimental) thinning-pruning late in winter had produced on the average on a tree.

Results and Discussion

Examination 1 has evidenced the significant difference between the mechanical water conductivity of the wounded and not wounded sector both in the case of the pruning site of the back pruning to terminal bud and of pruning site originating from the removal of the lateral branch.

From Tables 1 and 2 it appears that the mechanical water conductivity of the wounded sector was in the first case 28 per cent, in the second case 43 per cent lower as compared with the unwounded sector. In the first case the mean branch diameter and cicatrice diameter were 21 mm while in the latter case the mean branch diameter was 19 mm and on it the mean diameter of the pruning sites originating from the removal of the lateral branches was 12 mm. (See also Figs 1 and 2.)

Table 1

Sectorial development of the mechanical water conductivity in the region of pruning in the case of pruning to terminal bud

(Variety: *Jonathan* apple)

Replication	Wounded sector		Unwounded sector	
	cm^3/mm^2	rel. %	cm^3/mm^2	rel. %
1.	0.009	65	0.014	100
2.	0.009	65	0.014	100
3.	0.018	95	0.019	100
4.	0.012	70	0.017	100
5.	0.009	47	0.019	100
6.	0.013	100	0.013	100
7.	0.009	69	0.013	100
8.	0.009	41	0.022	100
9.	0.010	58	0.017	100
10.	0.020	100	0.020	100
11.	0.017	89	0.019	100
12.	0.015	71	0.021	100
Mean		*72*		*100*

$SD_{0.1\%} = 7$

Thus, as it appears also from Fig. 1, the side of the pruning site is mainly responsible for the disorders of the material transport.

It should be noted that we conducted examinations concerning the sectorial conductivity on branch parts both intact (without wounding and pruning site) and with apical bud site. On these of course the sectors were

Table 2

Sectorial development of the mechanical water conductivity in the case of removing a lateral branch in the pruning region

(Variety: *Jonathan* apple)

Replication	Wounded sector		Unwounded sector	
	cm^3/mm^2	rel. %	cm^3/mm^2	rel. %
1.	0.007	26	0.026	100
2.	0.019	86	0.022	100
3.	0.024	114	0.021	100
4.	0.014	77	0.018	100
5.	0.012	44	0.027	100
6.	0.011	37	0.029	100
7.	0.008	47	0.017	100
8.	0.010	34	0.029	100
9.	0.015	93	0.016	100
10.	0.010	52	0.019	100
11.	0.011	47	0.023	100
12.	0.007	33	0.021	100
Mean		*57*		*100*

$SD_{0.1\%} = 37$

selected at random. The results indicated again similar differences in conductivity. These differences were modified though but still subsisted when on the same material we turned the plane of separation by 90°. All this can be attributed also to the dorso-ventral differences of the various branches and to the isodiametrical condition of tissue formations observable in transversal section. Still these facts do not wipe out but even increase the significance of the material transport disorder indicated by the pruning sites in the wounded sector, since this so strongly acts on transport that it covers the differences in conductivity which arises also under undisturbed conditions and consistently gives rise to significant differences also at the 0.1 per cent level as compared with the unwounded sector. This is supported by our examination concerning calcium transport which is discussed in the following.

Examination 2 wants to conclude from the developments of the not reutilizing calcium content on the sectorial development of the ascending nutrient salt flow in the region of pruning site and apical bud site.

It appears from Table 3 that calcium content over the pruning site in the wounded sector is relatively 76—81 per cent if the calcium content of the wounded sector below the pruning site is considered as 100 per cent. On such relative basis in the region of the pruning site substantially more calcium

Table 3

Sectorial development of calcium content in per mille of dry matter in the region of pruning site and site of apical bud

(Variety: *Jonathan* apple)

Treatment	1.	2.	3.	4.	5.	6.	Relative %	
	replication						mean	SD_5 %
Wounded sector below pruning site	9.22	9.29	9.64	10.65	10.65	8.65		
Wounded sector above pruning site	6.71	7.07	8.72	6.71	8.21	7.07		
Ca-content of wounded sector above pruning site in rel. % when the wounded sector below pruning site = 100%	72.80	76.00	90.40	63.00	77.00	81.70	76.81	
Unwounded sector below pruning site	7.07	7.50	7.28	9.00	9.72	7.93		
Unwounded sector above pruning site	7.28	8.72	8.21	8.21	7.79	6.50		
Ca-content of unwounded sector above pruning site in rel. % when the unwounded sector below pruning site = 100%	121.00	116.00	112.00	91.20	90.40	81.90	102.08	
"a" sector below apical bud site	5.68	6.18	6.18	5.68	6.57	3.93		20.87
"a" sector above apical bud site	6.39	6.04	5.68	6.93	6.64	6.43		
Ca-content of "a" sector above apical bud site when the "a" sector below it = 100%	112.00	97.70	91.90	116.00	101.00	163.60	113.70	
"b" sector below apical bud site	6.18	5.61	5.61	5.75	6.50	5.71		
"b" sector above apical bud site	6.04	5.75	5.54	6.50	5.36	6.07		
Ca-content of the "b" sector above apical bud site when the "b" sector below it = 100%	97.70	102.40	98.70	113.00	82.40	106.30	100.08	

could proceed upwards with the ascending flow of sap than in the wounded sector because there (viz. in the unwounded) in the part above the pruning site the relative calcium content is 102.08 per cent as compared with the part below that site.

In both cases the sectorial developments of calcium content are higher in the part above the apical bud site than in the corresponding lower part which proves absence of prevention of the ascending sap flow also in the region of the apical bud site. From Table 3 it also appears on the basis of relative percentual evaluation that as to the disorder of the transport of nutrient material there is no significant difference between the sectors of the apical bud site and the unwounded sector of the pruning site. The more pregnant is the difference between the wounded sector of the pruning site and the three sectors referred to. This phenomenon at the same time supports our statement in connection with *Examination 1* according to which the material transport disorder caused by the wounded sector of the pruning site absolutely covers the differences in sectorial conductivity due to the natural tissue formations (Fig. 3).

Examination 3 utilizes the development of the pullulating edge of the cicatrice caused by the pruning, that is, of the wound wood as a physiological test (Fig. 4). On the distal part of the wound the development of the wound edge arch of the wound wood reflects essentially the effect of the excessive organic matter state of supply and deficient mineral matter transport, while on the proximal part the effect of deficient organic matter supply and excessive mineral stuff supply. The control is naturally the development of the two lateral wound edge arches. The wound wood of the lateral arches is essentially in connection with the parts of ascending and descending sap flow of the branch and

Table 4

Various types of the development of the distal (D), and proximal (P) wound wood arch

(Variety: *Jonathan* apple)

Types	Diameter mm		$SD_{5\%}$
	D	P	
$D > P$	5.66	3.35	2.02
$D < P$	3.47	6.36	0.92
$D = P$	4.36	4.36	—

on the other hand it creates a connection between the upper and lower part of the wood and thus its organic and inorganic nutrient supply is harmonical as compared with the distal and proximal arches both on the one side and on the apices; therefore it reflects the nutritional status of the unwounded sector as compared with the nutrient supply conditions of the wounded sector.

Examining more than 100 several years old cicatrices healed to various degrees and selected at random of 10 *Jonathan* trees we found that in 55 per cent of the cicatrices the distal wound wood arch had been more developed as compared with the proximal (Fig. 3, D > P), in 35 per cent the proximal was greater than the distal (D < P) and only in 10 per cent of the cases examined was the diameter of the distal wound wood arch indicated with points equal with that of the proximal (D = P). At the same time, relating the mean diameter of the two lateral wound wood arches $\left(\frac{L_1 + L_2}{2}\right)$ to the mean diameter of the distal and proximal wound wood arches $\left(\frac{D + P}{2}\right)$ in 95 per cent of the cases the average growth of the lateral parts proved to be greater than the average growth of the distal and proximal parts. All this proves that in the vital functions of the tree the gap brought about by the woundings creates a disharmony in the nutritional status of the parts above and below the pruning site.

Table 5

Development of the distal (D), proximal (P) and lateral (L_1, L_2) wound wood arches in 100 cicatrices examined, on the average

(Variety: *Jonathan* apple)

Distal and proximal wound wood arches mean Ø mm $\frac{D+P}{2}$	Lateral wound wood arches mean Ø mm $\frac{L_1+L_2}{2}$	$SD_{5\%}$
4.81	8.07	2.53

The type D > P reflects the state when at the distal wound wood arch the concentration of the organic matters and of growth hormones is not yet too high and at the same time the nutrient salt supply is also still in some measure satisfactory; at the same time in the proximal part a deficiency of organic matters and growth hormones manifests itself which in no way can be compensated by the supraoptimal nutrient salt supply. The type D < P is the opposite of the above where in D the supraoptimal concentration of organic matter and growth hormone and the deficiency of the mineral nutrient salts make themselves felt already while in the proximal part the concentration of the organic matters and growth hormones does not fall too deep so that the abundant nutrient salt supply can become effective in the development of the proximal wound wood. Only in 10 per cent of the cases appeared — as already referred to — the D = P type which indicates that various internal causes may manifest themselves in the same way since there is no doubt that in the development of the distal part organic matter and growth hormones of relatively higher concentration and mineral matter of relatively lower concentration could have been involved than in the case of the proximal part. That, however, a disorder of the material transport subsisted also here is proved by the fact that in these cases too there was a difference between the distal and proximal wound wood arches of similar development and the mean diameters of the lateral wound wood arches.

All three types agree in that — as already mentioned before — the mean diameter of the distal and proximal parts is lower than the similar mean of the lateral parts (Table 5). It should be noted that the wound diameter of the 100 pruning sites examined was 17.99 mm on the average.

Examination 4 was conducted outdoors in the orchard area. It was examined how many pruning sites and of what surface per tree were produced by the interference in a 17-year-old *Jonathan* orchard of bearing age that had received farm-scale thinning-pruning. The results of the survey are condensed in Table 6.

Table 6

Survey of woundings by farm-scale thinning-pruning late in winter of Jonathan apples of bearing age on wild stock

Repli-cation	Stem-circum-ference, cm	Stem height, m	Crown height, m	Crown ⌀ m	Cica-trices, units	Total: cicatrice surface, cm^2	Total: cicatrice circumference, cm	Mean ⌀ of a cica-trice, cm	Mean surface of 1 cica-trice, cm^2	Mean circum-ference of 1 ci-catrice, cm
1.	60	1.30	3.70	5.45	213	146.97	628.35	0.94	0.69	2.95
2.	61	1.45	3.30	5.75	284	187.44	829.28	0.93	0.66	2.92
3.	69	1.40	4.00	6.55	267	210.93	838.38	1.00	0.79	3.14
4.	54	1.45	3.00	5.17	223	189.55	735.90	1.05	0.85	3.30
5.	41	1.25	2.45	4.10	63	49.77	197.82	1.00	0.79	3.14
6.	74	1.27	4.15	6.62	345	208.75	1072.95	0.99	0.75	3.11
Mean	59	1.35	3.43	5.60	232	165.40	717.11	0.96	0.75	3.09

According to these data in the course of the thinning-pruning conducted late in winter on the average 232 woundings were performed on a tree the total surface of which was 0.0165 sq.m. The length of the pullulating edge thus produced exceeds 7 m per tree. The mean surface of a wound is 0.75 sq.cm and its mean diameter 0.96 cm. When connecting this with our previous argumentation we must absolutely reckon with the fact that with the pruning interference of a unique year an enormous material transport disorder was brought about. Reflecting this back to the woundings performed at the time of the forming pruning and to all — if not always so intensive — thinning-prunings in the course of the years we must recognize that our interferences entangle and render anarchic the vital activities of the tree far better than they regulate it. We only refer to the long known effectivity of the incisions below and above the bud (OKÁLYI—MALIGA 1956) with the aid of which by realizing a gap of a few mm in the phloem shooting, dormancy or energy of shooting can be influenced. Now — according to the present survey — the thinning-pruning of a single year brought about on a tree 232 wounds on the average which produced moderately calculated gaps corresponding to 2300 incisions above or below the bud in the phloem and the "effectivity" on these pruning sites is still enhanced by the fact that they cause also in the xylem considerable disorder in the material transport.

Conclusion

Three out of four examinations of ours attempted to elucidate with the further development of our earlier experiments the nature of the disorder of material transport caused by the pruning of fruit trees. What had appeared already in the course of earlier examinations by the attaining of the active vascular tissues (Fig. 1) obtained now further experimental verification.

In the course of our examinations it has gained certainty that the disorder of the material transport is of sectorial character and comes into being mainly in the so-called wounded sector at the side of the pruning site. Therefore, we believe that it will be proper to name this phenomenon in the future "sectorial material transport disorder induced by pruning".

REFERENCES

BRUNNER, T. (1965): A gyümölcsfametszés hatásának vizsgálata és kritikai elemzése, különös tekintettel a szállítószövetekben okozott defektusokra (Examination and Critical Analysis of the Effect of Fruit-tree Pruning with Special Reference to the Defects Caused in the Translocating Tissues). Budapest. Kísérleti Közlemények, Kertészet, 2, 3—22.

COUTANCEAU, M. (1953): Arboriculture fruitiere. Paris.

FEJES, S.—HORN, E.—BRUNNER, T. (1966): Gyümölcssövény (Fruit Hedge). Mezőgazdasági Kiadó. Budapest.

FRENYÓ, V. (1959): Növényélettan (Plant physiology). Mezőgazdasági Kiadó, Budapest.

FRENYÓ, V. (1964—66): Növényélettani előadások az Eötvös L. Tudományegyetemen (Lectures on Plant Physiology at the L. Eötvös University). Budapest.

OKÁLYI, I.—MALIGA, P. (1956): Gyümölcstermelés (Fruit Production). Mezőgazdasági Kiadó. Budapest.

PORPÁCZY, A. *et al.* (1964): A korszerű gyümölcstermelés elméleti kérdései (The Theoretical Problems of Modern Fruit-growing). Mezőgazdasági Kiadó. Budapest.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 25—36 (1968)

NITRIFICATION CAPACITY OF THE SOILS OF MARSHY AND HAY MEADOWS

By

M. Kovács

BOTANICAL RESEARCH INSTITUTE OF THE HUNGARIAN ACADEMY OF SCIENCES, VÁCRÁTÓT

Nitrification capacity of the *Agrostion* and *Arrhenatherion* meadows of Transdanubia has been examined under laboratory conditions in connection with the soil type. The associations of the two groups can be separated on the basis of their soil ecological properties and nitrification capacity. Locally (especially in the case of contact associations) the ecological sequence of the associations can be established on the basis of nitrogen demand. Results of the investigations may find use in practical meadow farming (amelioration).

Introduction

Examinations following the periodical or annual changes of the nitrogen content of the soil inform us on the amount of nitrogen occurring in the given moment and on the extent of annual fluctuation, while they reveal little of the nitrogen supplying capacity of the soil and the nitrogen provision of the vegetation. For the species demanding nitrogen of the soil not the amount of nitrates available at a given moment is important but rather the measure of nitrate supply by nitrification (Walter 1960).

Examinations of "soil ripening", a method first used by Scandinavian workers (Hesselmann 1917) to establish the relation between biological activity and vegetation, inform us on the potentially possible nitrogen supplying capacity of the soils of the plant associations, its intensity and indirectly of the amount of nitrifying microorganisms.

The examinations can be also utilized to establish the nitrogen demand of various plant associations (plant species). On the basis of the examinations of a number of research workers (Schönhar 1955, Meyer 1957, Zöttl 1958, 1960, 1965, Walter 1963, Ellenberg 1964, Kovács 1961, 1964, 1965) the nitrogen conditions of the various habitats are best characterized by the results of soil ripening examinations.

Material and Method

Ecological examinations conducted in the Transdanubian area since 1962 have been extended to the nitrification capacity of the soils of larger, agriculturally useful marshy *(Agrostion: Alopecuretum pratensis, Festucetum pratensis, Deschampsietum caespitosae)* and hay meadows *(Arrhenatherion: Arrhenatheretum elatioris)* as well as to the examination of the more

Table 1

Examination data and nitrification capacity of the soils of Agrostion and Arrhenatherion meadows

Serial number	Mark	Plant association	Locality	pH in water	pH in nKCl	y_1	$CaCO_3$ %	Humus %	Ca	K	NH_3	NO_3	Amount of NO_3 formed in 28 days, mg/100 g
									content of soil solution mg/100 g				
1.	1/62	*Alopecuretum pratensis*	Gyulafirátót	7.9	7.2	.	12.8	.	30.9	.	1.4	2.4	28.0
2.	14/62	,, ,,	Pókaszepetk	.	.	.	.	.	.	.	.	.	27.5
3.	16/63	,, ,,	Vindornya	7.5	7.2	.	9.6	.	47.1	1.7	0.2	0.6	29.2
4.	1/64	,, ,,	Bokod	7.1	6.9	2.0	4.9	1.9	66.4	0.7	ny	0.9	31.5
5.	5/64	,, ,,	Köveskál	7.3	6.9	2.5	11.6	1.7	48.8	5.2	ny	0.7	38.3
6.	9/64	,, ,,	Türje	6.9	6.7	4.0	1.6	1.6	57.4	2.5	0.1	0.6	36.6
7.	7/65	,, ,,	Zalaszentbalázs	7.6	7.3	2.5	6.6	2.2	25.5	0.6	0.7	1.8	38.4
8.	13/65	,, ,,	Várvölgy	7.5	7.1	1.2	11.2	2.6	27.6	1.3	0.7	2.9	46.3
9.	3/62	*Deschampsietum caespitosae*	Várvölgy	7.3	6.9	.	2.4	.	34.1	.	2.6	1.7	31.5
10.	12/62	,, ,,	Alibánfa	7.6	7.0	.	4.0	.	33.1	.	2.2	2.5	25.0
11.	3/63	,, ,,	Kisunyom	6.9	6.8	.	3.2	.	27.8	0.8	0.2	0.4	21.2
12.	8/63	,, ,,	Kálóz*	7.6	7.4	.	19.2	.	40.5	1.2	0.2	0.7	39.2
13.	17/63	,, ,,	Nemestördemic*	7.4	7.2	.	20.3	.	46.6	0.6	0.2	0.8	52.7
14.	2/64	,, ,,	Bokod	7.2	7.0	2.0	11.5	1.0	35.3	0.7	0.1	0.8	24.8
15.	4/64	,, ,,	Köveskál	7.3	7.0	2.2	14.2	1.8	48.8	1.4	0.1	1.4	31.7
16.	10/64	,, ,,	Türje	7.2	6.9	3.0	7.6	2.6	62.3	1.0	0.1	0.9	45.5
17.	1/65	,, ,,	Balatonszemes	7.8	7.6	2.2	11.2	1.9	20.1	0.4	0.8	1.2	34.1
18.	6/65	,, ,,	Zalaszentbalázs	7.5	7.2	2.5	13.3	2.3	25.3	0.8	0.7	1.9	40.1
19.	10/65	,, ,,	Várvölgy	7.4	7.0	2.2	7.2	2.4	21.9	0.8	0.7	0.9	39.4
20.	5/62	*Festucetum pratensis*	Zalalövő	7.6	6.8	.	0.0	.	33.1	.	2.4	2.0	13.0
21.	7/62	,, ,,	Zalalövő	6.0	4.6	.	0.0	.	9.9	.	1.9	5.1	13.7

22.	10/62	,,	,,	Zalaszentgyörgy	7.5	6.6	.	0.0	.	30.9	.	0.9	1.6	25.6
23.	5/63	,,	,,	Hosszupereszteg	7.4	7.1	.	4.7	.	28.3	1.1	0.1	1.3	22.0
24.	7/63	,,	,,	Somlójenő	7.4	7.3	.	6.4	.	41.6	1.7	0.1	1.8	35.2
25.	10/63	,,	,,	Pincehely	7.7	7.5	.	42.7	.	35.3	0.8	0.4	1.8	45.0
26.	14/63	,,	,,	Böhönye	6.6	6.5	.	2.9	.	15.7	0.7	ny	0.9	8.0
27.	15/63	,,	,,	Sormás	7.2	7.0	.	4.3	.	.	.	0.1	0.5	45.0
28.	3/64	,,	,,	Hegyesd	7.1	7.0	2.0	8.1	1.4	37.9	0.2	0.1	0.6	33.1
29.	10/64	,,	,,	Andráshida	6.5	6.4	3.2	1.6	1.7	52.9	0.3	0.2	0.4	37.6
30.	16/64	,,	,,	Nemesvita	7.2	6.9	2.7	10.8	1.2	42.4	0.4	0.1	0.4	34.7
31.	9/65	,,	,,	Zalaszentgrót	7.3	7.0	2.7	1.6	1.7	17.5	0.6	ny	1.2	34.3
32.	14/65	,,	,,	Várvölgy	7.4	7.2	2.5	15.6	2.1	26.6	0.7	0.7	0.6	40.4
33.	1/63	*Arrhenatheretum*		Csepreg	6.4	6.1	.	2.6	.	13.7	1.5	0.1	0.5	13.0
34.	2/63	,,		Csepreg	7.1	6.6	.	2.8	.	25.0	1.2	0.1	0.3	25.0
35.		,,	*typicum*	Csepreg	6.2	5.7	.	0.0	.	7.0	1.0	ny	0.9	15.2
36.		,,	*salvietosum*	Csepreg	6.9	6.6	.	2.8	.	9.5	1.1	ny	0.8	15.2
37.	12a/63	,,	*salvietosum*	Kaposfő	6.4	6.3	.	.	.	8.0	1.3	0.1	0.6	11.0
38.	12b/63	,,	*typicum*	Kaposfő	6.9	6.7	.	2.3	.	12.5	0.7	0.1	0.7	11.0
39.	6/64	,,		Baktüttös	5.3	4.7	18.5	0.0	1.3	4.9	0.8	ny	0.3	5.9
40.	7/64	,,		Zágorhida	5.8	5.5	8.5	0.0	1.2	13.1	0.7	0.1	0.6	16.8
41.	8/64	,,		Zalalövő	5.8	5.0	13.2	0.0	1.2	4.5	0.7	ny	0.3	10.9
42.	12/64	,,		Egyházasrádóc	5.5	4.8	15.5	0.0	1.3	4.6	0.6	ny	0.1	5.5
43.	13/64	,,		Ozmánbük	5.8	5.3	11.2	0.0	1.5	6.4	0.5	0.1	0.6	10.4
44.	14/64	,,		Zebeck	5.5	4.8	16.2	0.0	1.3	0.8	1.0	ny	0.3	9.9
45.	15/64	,,		Tófej	6.9	6.6	3.0	0.0	1.0	27.4	0.5	0.1	0.6	19.8
46.	2/65	,,		Hollád	6.8	6.6	5.0	0.7	1.5	11.9	0.5	0.1	2.4	30.4
47.	4/65	,,		Zalaszentbalázs	7.3	6.8	2.7	0.8	1.0	1.0	0.9	0.2	2.1	27.1
48.	8/65	,,		Zalaszentbalázs	6.7	6.1	5.7	0.6	1.4	9.6	0.5	0.3	1.1	15.9

Serial number	Mark	Plant association	Locality	pH in water	pH in nKCl	y	$CaCO_3$ %	Humus %	Ca	K	NH_3	NO_3	Amount of NO_3 formed in 28 days, mg/100 g
									content of soil solution mg/100 g				
	Magnocaricion												
49.		*Caricetum elatae*	Somlójenő*	7.3	7.2	.	.	.	.	.	.	.	50.0
50.	11/64	*Caricetum gracilis*	Andráshida	7.2	6.8	2.5	2.8	1.9	67.5	0.3	ny	0.4	28.7
51.	9/63	,, ,,	Simontornya	7.7	7.4	.	13.6	.	33.5	0.9	ny	0.9	45.0
52.	11/63	,, ,,	Kaposfő	7.6	7.5	.	11.3	.	33.7	0.7	0.9	0.4	26.2
	Caricion davallianae												
53.	22/64	*Schoneteum nigricantis*	Öskü*	7.4	7.3	2.0	65.7	.	87.0	0.3	0.1	3.0	48.5
54.	25/64	,, ,,	Lesencetomaj*	7.3	7.1	2.5	30.3	.	81.0	0.8	0.4	2.7	46.5
55.	24/64	*Juncetum subnodulosi*	Türje	7.2	7.0	2.5	5.4	2.2	64.9	0.2	0.1	1.4	39.6
56.	27/64	,, ,,	Lesencetomaj*	7.3	7.1	2.5	6.5	.	49.9	0.3	0.1	1.0	37.6
57.	21/64	*Seslerietum uliginosae*	Öskü	7.3	7.2	1.0	56.9	4.6	128.6	1.2	0.3	4.5	63.4
58.	14/64	,, ,,	Sopron	7.1	6.9	2.5	9.5	3.2	82.9	1.2	0.1	0.7	29.7
59.	26/64	,, *molinietosum*	Lesencetomaj*	7.2	7.1	1.0	38.9	.	79.9	2.6	0.6	4.8	22.7
	Molinion coeruleae												
60.	23/64	*Molinietum caricetosum hostianae*	Bakonygyepes	7.2	7.1	3.0	40.4	2.4	64.5	0.2	ny	1.5	37.6
61.	15/65	*Molinietum caricetosum paniceae*	Várvölgy	7.6	7.2	2.2	21.2	1.6	20.5	0.3	0.2	2.1	28.3

In localities marked * the soil is peat.

important soil factors influencing this capacity (Table 1). The date of average soil sampling per stand was the spring aspect (month of May). Beside the soils of the marshy and hay meadows for comparison also the soils of high sedge *(Magnocaricion)*, calciphilous fens *(Caricion davallianae)* and drying-out moor meadows *(Molinion coeruleae)* have been examined.

The nitrification examinations were conducted under laboratory conditions with the so-called "soil ripening" method (FJODOROV 1952, BALLENEGGER 1953).

Results and Discussion

a) *Nitrification and soil types.* The nitrification capacity is a complex agent influenced by a number of soil chemical factors. From the nitrification conditions prevailing in the habitat it may be concluded on the reaction, $CaCO_3$ and Ca-ion content of the soil, the adsorption complex (MORAVEC 1963) as well as on the water and air supply.

A great part of the marshy meadows of Transdanubia are spreading on calcareous meadow soil of neutral and alkaline reaction, excepting — in the Upper Zala valley — the *Festuca pratensis* stands of uncertain coenological position occurring on lime deficient meadow soil of acid reaction. *Arrhenatherum* hay meadows are frequent (partly owing to the ecological demand of the association) mainly on meadow soils of acid reaction and deficient in lime (on calcareous meadow soils its stands occur with less frequency). The meadow plant associations have a centre of gravity of habitat (and besides a definite ecological amplitude). The nitrification capacity can be only measured in connection with the soil type and the plant association. For the same plant association (e.g. *Deschampsietum*) the nitrification of the soil and its intensity are different on meadow, moor-meadow and peat soil.

On calcareous meadow and moor soils of alkaline reaction and rich in bases nitrification is good while acid reaction, $CaCO_3$ deficiency and low Ca-ion content hinder the nitrification. Intensity of nitrification reacts on the composition of the plant cover and may determine the appearance of certain plant associations.

In the moor soil of the fen associations *(Caricion davallianae)* all factors are given (basic reaction, high $CaCO_3$, Ca-ion and organic matter content) that are favourable for the dynamics of nitrification. Under natural conditions the saturation of soil with water (water cover) and low specific heat hinder the more intensive biological processes.

The nitrogen supplying capacity of the moor soils is very good (VÁRALLYAI 1937). On their intensive nitrification dynamics is based their fertility after amelioration or after the breaking up of moor areas or the cut and burning of peat and the mass appearance of the nitrogeniphilous weed vegetation. Total nitrogen content of moor soils is as a rule very high (0.4—2.2 per cent according to the examinations of VÁRALLYAI 1937). The great amount of nitrogen can transform into available nitrogen only to a certain degree. In spite of the high nitrogen content of the moor soils and the intensive nitrification dynamics measurable under laboratory conditions the moor meadows of *Caricion davallianae* character cannot be considered as nitrogeniphilous. ELLENBERG (1963) qualifies the stand-constituting species of the moor meadows pertaining here on the basis of their nitrogen demand (N-number, in detail see later) as of value 1. The N value number calculated on the basis of the floristic composition is low as compared with the marshy and hay meadows (1.1—1.7). In the course of the natural progress of succession with the drying out of the moor areas and the appearance of the *Molinia* meadows the nitrification process of the soil accelerates and in the stands of *Molinietum coeruleae* species more demanding for the nitrogen content of the soil appear already. The N value number calculated on the basis of the floristic composition may rise over 2.

The pH value of the soils (as a complex factor) may influence the amount of nitrate production of the meadow and moor soils (Table 2).

Table 2

Relationship between pH of the soil and nitrate production

(on the basis of the frequency of 105 samples)

pH value	mg NO_3/100 g the values of nitrate production during the 28 day soil ripening					
	0—10	10—20	20—30	30—40	40—50	50—
5.3—5.5	3	.	.	.	.	.
5.6—6.0	1	5	.	.	.	.
6.1—6.5	.	3	1	1	.	.
6.6—7.0	1	4	4	3	.	.
7.1—7.5	.	1	15	27	12	2
7.6—7.9	.	2	7	11	2	.

b) *Relationship between the potential nitrate production of the soils of the plant associations and the N (nitrogen value) number calculated on the basis of the floristic composition.* According to the data of Table 1, in Transdanubia, on meadow soils it is difficult — by the nitrification capacity — to draw a distinction among the different associations of marshy meadows.

The data of the soil ripening examinations supply reliable, differential results for the relative nitrogen demand — at identical habitat (and of geographically identical site) — for plant associations being as a rule in contact with each other. On this basis it can be concluded on the nitrogen demand of the various plant associations and the ecological amplitude related to the nitrogen demand can also be established.

As regards the examination of the relative nitrogen demand of *Alopecuretum pratensis* and *Festucetum pratensis* stands the samples have originated from four places, from stands in contact with each other and from the identical soil type (flood area of the river Ipoly, Bokod, Köveskál, Várvölgy). The soil ripening examinations (Fig. 1) evidenced in all cases the higher nitrogen supplying capacity of the soil of *Alopecuretum* as compared with the soils of the stands of *Festucetum pratensis*. The so-called "time curves" of the *Alopecuretum* soils show the rapid realization of nitrogen mineralization and early on the seventh day a considerable amount of NO_3 could be measured which points to the presence of a great amount of nitrate bacteria. Out of the meadow associations investigated by MORAVEC (1965) the soil of the rhizosphere of *Alopecuretum (Agropyro — Alopecuretum)* exhibited the highest nitrification capacity. For the soils of *Festucetum pratensis* stands generally a longer adaptation of microbe population is necessary.

The stands of *Alopecuretum pratensis* are more demanding as against the nitrogen content (nitrogen supplying capacity) of the soil than *Festucetum pratensis* or *Deschampsietum caespitosae*. The stands on peat soil of *Deschampsietum caespitosae* (which among the marsh meadows on account of its floristic composition and soil demand is most related to moor meadows) show more intensive nitrification (the amount of NO_3 produced in 28 days is 39—52 mg/100 g) than those on meadow soil (24—45 mg/100 g).

ELLENBERG (1952, 1964) has established value numbers for the light, heat, moisture, chemical reaction and nitrogen requirement of the Central-European meadow plants and these do not indicate the physiological demands of the various species but the centre of weight of their spreading. The value numbers serve first of all for the characterization of the various stands while the mean value calculated on the basis of the value numbers (on the basis of group participation) makes it possible to characterize the habitat by the indicator plant combination.

For the coenological surveys of the marshy and hay meadows using ELLENBERG's value numbers (and ranging the domestic species according to our own investigations) we have carried out the calculation of the "N" value. The calculation was conducted not on the basis of group participation but of the coverage value (group mass). This is particularly justified in the establishment of nitrogen demand because the massive occurrence of a species (especially if this latter is demanding upon the nitrogen content of the soil) depends more on nitrogen conditions than the mere appearance of the species in question. E.g. *Alopecurus pratensis* occurs from *Magnocaricion* meadows to marshy meadows in almost every association but can be found in masses only in readily nitrificating habitats rich in nitrogen.

Between the nitrification capacity of the soils of the various stands and the value number N calculated by the floristic composition a relationship can

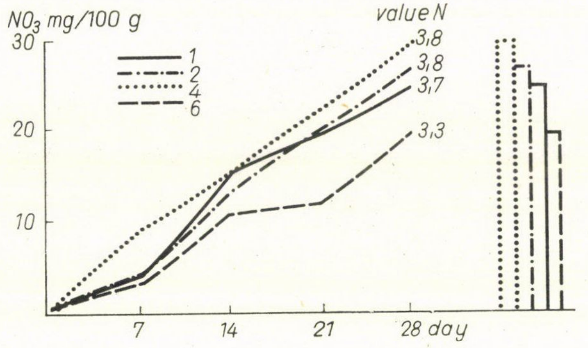


Fig. 1a

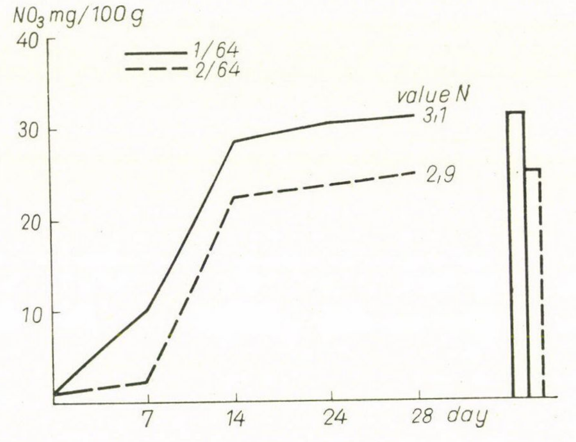


Fig. 1b

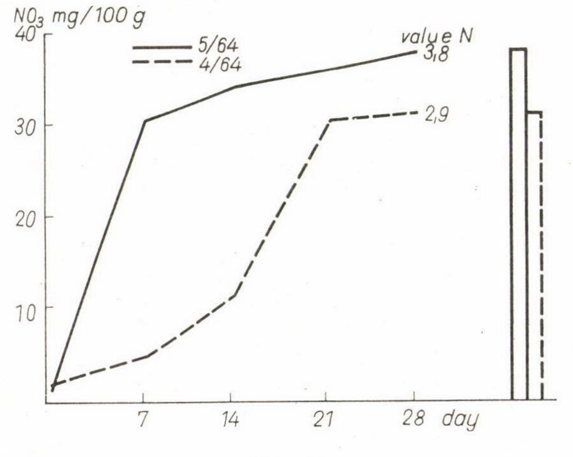


Fig. 1c

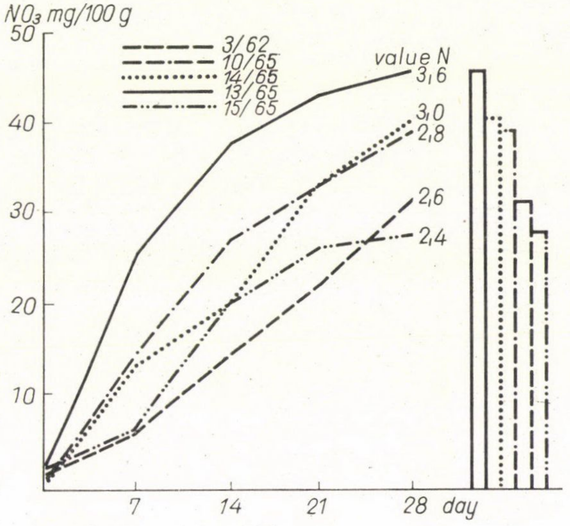


Fig. 1d

Fig. 1. Value number N of *Alopecuretum* stands and nitrification of their soils as compared with the *Festucetum pratensis (Deschampsietum caespitosae)* stands. *a)* Flood area of the river Ipoly, 1. 2. 4. *Alopecuretum pratensis*, 6. *Festucetum pratensis*. *b)* Bokod, 1/64 *Alopecuretum pratensis*, 2/64 *Deschampsietum caespitosae*. *c)* Köveskál, 5/64 *Alopecuretum pratensis*, 4/64 *Deschampsietum caespitosae*. *d)* Várvölgy, 13/65 *Alopecuretum pratensis*, 14/65 *Festucetum pratensis*, 10/65 and 3/62 *Deschampsietum caespitosae*, 15/65 *Molinietum caricetosum paniceae*

be established (Fig. 2). The value number N of the *Alopecuretum pratensis* stands with higher NO_3 production was in every case higher than that of *Festucetum pratensis*. In the case of the Várvölgy stands *(Alopecuretum pratensis, Festucetum pratensis, Deschampsietum caespitosae, Molinietum caricetosum paniceae)* the sequence to be established on the basis of the value number N and of the nitrification capacity of the soil corresponds to the ecological sequence of the various plant associations according to (hitherto only empirical) nitrogen demand. This ecological sequence is also valid for the marshy meadows of Transdanubia.

	Value number N	NO_3 mg/100 g developed in 28 days
Alopecuretum pratensis	3.5	34.6
Festucetum pratensis	3.1	34.4
Deschampsietum caespitosae	2.6	32.5

(The figures are average values and evaluation has been made only for the stands of identical soil type.)

c) *Ecological characterization of plant associations on the basis of two-dimensional representation.* On the two-dimensional Figure the marshy and hay meadows are discerned according to their ecological amplitude on the basis of the pH value of the soil and of the potential nitrate producing capacity.

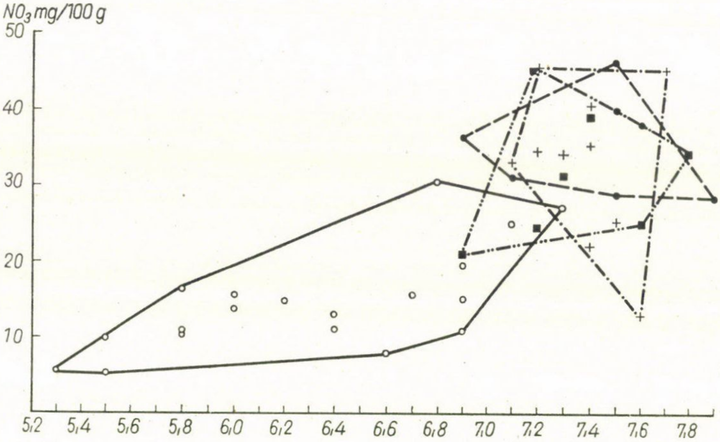


Fig. 2. Ecological position of the marshy and hay meadows on the basis of pH value and potential nitrate production of the soil ——— *Arrhenatheretum elatioris*, - - - - *Alopecuretum pratensis*, -·-·-· *Festucetum pratensis*, -··-··- *Deschampsietum caespitosae*

Differential factor is the reaction of the soil. The relationship which can be established on the basis of nitrate producing capacity and pH value influencing the latter corresponds to the ecological sequence of the plant associations. The position of the marshy meadows occupied on the Figure reflects the nearly identical ecological conditions of the associations pertaining here *(Alopecuretum pratensis, Festucetum pratensis, Deschampsietum caespitosae)* and at the same time determines the close floristic relationship. (Separation of the associations of the *Agrostion* group on the basis of floristic composition is difficult and often takes place by allowing for the dominant species.) The hay meadows with common oat grass of the *Arrhenatherion* group in their floristic composition and as a consequence of their nitrification conditions determined on account of their ecological demand sharply differ from the marshy meadows. (The two-dimensional diagram is valid for the area of Transdanubia !) On calcareous meadow soil *Arrhenatherum* meadows can also develop following the drying out of the marshy meadows; this is indicated by the ecologically delimited "area" of *Arrhenatheretum* and its part in contact with *Agrostion* respectively.

On the Figure showing the value number N of the plant associations and the nitrification capacity of their soils (Fig. 3) the moor and marsh meadows are placed on the grounds of the ecological sequence created by the value number N. In the *Caricion davallianae* moor meadows the place occupied on the diagram is determined by the special soil demand (peat) of the associations pertaining here and the lack of demand for nitrogen of the stand-constituting species. *Deschampsietum* separates — to a certain degree — from *Alopecuretum* and *Festucetum pratensis.* Its cause, the comparatively wide soil ecological (soil type) amplitude, can be equally found on meadow, moor meadow and

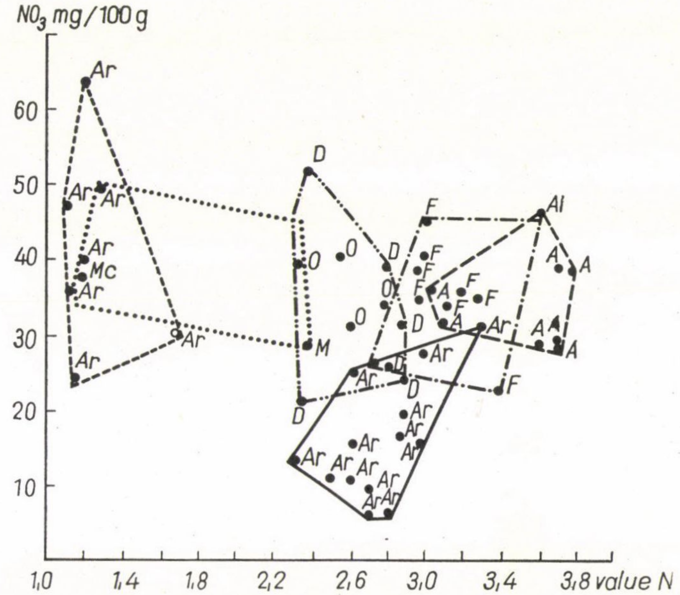


Fig. 3. Ecological position of the moor, marsh and hay meadows on the basis of the value N of the stands and of the nitrification capacity of their soils .... *Caricion davallianae*, ... *Molinion coeruleae* (basiphilic), - - - - *Alopecuretum pratensis*, -·-·-· *Festucetum pratensis*, -··-··- *Deschampsietum caespitosae*, ——— *Arrhenatheretum elatioris*

peat soil. Its floristic composition also shows often a relationship with moor meadows, especially its stands passing into *Molinietum coeruleae* are frequent. In the floristic composition of *Alopecuretum pratensis* the species more demanding for the nitrogen content of the soil are more frequent and occur in greater masses.

The value number N of the *Arrhenatheretum* stands is between 2.3—3.3 and *Arrhenatherum elatius* itself is, similarly to *Festuca pratensis* and *Alopecurus pratensis*, nitrogen demanding (of value 4 according to Ellenberg). Nitrification of the common oat grass meadows, as a consequence of the properties of the given soil type is low. On account of the nitrogen demand of *Arrhenatheretum* and the amelioration of the qualitative and quantitative conditions of the hay meadows belonging here it is necessary to increase the nitrogen supplying capacity of their soil. In Central and Western Europe these meadows are regularly manured and treated with dung-water respectively.

REFERENCES

BALLENEGGER, R. (1953): Talajvizsgálati módszerkönyv (Methodenbuch für Bodenkunde). Budapest, 1—411.

ELLENBERG, H. (1952): Wiesen und Weiden und ihre standörtliche Bewertung. Stuttgart, 1—143.

ELLENBERG, H. (1963): Vegetation Mitteleuropas mit den Alpen. Stuttgart, 1—943.

ELLENBERG, H. (1964): Stickstoff als Standortsfaktor. Berichte der Deutsch. Bot. Ges., **77**, 82—92.

FJODOROV, M. V. (1952): Mikrobiológiai gyakorlatok (Mikrobiologisches Praktikum). Budapest 1—237.

HESSELMANN, H. (1917): Studien über die Nitratbildung in natürlichen Böden und ihre Bedeutung in pflanzenökologischer Hinsicht. Medd. Stat. Skogsförsökanst. **13—14**, 297—527.

KOVÁCS, M. (1961): Die Schlagvegetation des Mátra-Gebirges. Acta Botanica Acad. Sci. Hung., **7**, 319—343.

KOVÁCS, M. (1964): Ökologische Untersuchungen von Sumpf- und Mähwiesen in der Umgebung von Galgamácsa. Acta Agronomica Acad. Sci. Hung., **13**, 61—91.

KOVÁCS, M. (1965): Anwendung von bodenbiologischen Methoden in pflanzengeographischen Forschungen I. Untersuchung der Nitratproduktion in den Waldböden des Mátra-Gebirges. Acta Botanica Acad. Sci. Hung., **11**, 361—382.

MEYER, F. H. (1957): Über Wasser- und Stickstoffhaushalt der Röhrichte und Wiesen im Elballuvium. Mitt. Staatsinst. f. Allg. Bot. Hamburg., **11**, 137—203.

MORAVEC, J. (1963): Stanovistni podminky nitrifikácni schopnosti pud nekterych lucnich rostlinnych spolecenstev (Standortsbedingungen der Nitrifikationsfähigkeit der Böden einiger Wiesengesellschaften). Rostlinna vyroba, **7—8**, 852—859.

MORAVEC, J. (1965): Wiesen im mittleren Teil des Böhmerwaldes (Sumava). In: Synökologische Studien über Röhrichte, Wiesen und Auenwälder. Vegetace CSSR. A 1. Prag, 179—385.

SCHÖNHAR, S. (1955): Untersuchungen über das mengenmässige Auftreten von Nitrat-Ammoniakstickstoff in Böden verschiedener Waldstandorte. Forstwiss. Zentralbl., **74**, 129—192.

VÁRALLYAI, GY. (1937): Oldhatóvá válik-e láptalajaink nitrogénje (Solubility of the Nitrogen of Hungarian Moor Soils). Köztelek, **47**, 698—699.

WALTER, H. (1960): Einführung in die Phytologie III. Standortslehre. Stuttgart, 1—566.

WALTER, H. (1963): Über die Stickstoffansprüche (die Nitrophilie) der Ruderalpflanzen. Mitteil. Flor.-soz. Arbeitsgemeinschaft, **10**, 56—69.

ZÖTTL, H. (1958): Die Bestimmung der Stickstoffmineralisation im Waldhumus durch den Brutversuch. Zeitschrift f. Pflernährg. Düng. u. Bkde, **81**, 35—49.

ZÖTTL, H. (1960): Methodische Untersuchungen zur Bestimmung der Mineralstickstoffnachlieferung des Waldbodens. Forstwiss. Zentralbl., **79**, 72—90.

ZÖTTL, H. (1960): Dynamik der Stickstoffmineralisation im organischen Waldbodenmaterial I—III. Plant and Soil, **13**, 166—223.

ZÖTTL, H. (1965): Anhäufung und Umsetzung von Stickstoff im Waldboden. Berichte der Deutsch. Bot. Ges., **78**, 167—180.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 37—45 (1968)

CONTRIBUTIONS TO THE KNOWLEDGE OF SELF-PURIFICATION OF RENDZINA SOILS

By

I. Szabó, M. Marton, I. Buti

RESEARCH INSTITUTE OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
OF THE HUNGARIAN ACADEMY OF SCIENCES, BUDAPEST

In the non-sterile samples of a mull-like rendzina soil, *Aspergillus niger* lost 99.4 per cent of its original inoculation-number in 17 days while when it was cultivated together with the antagonistic strain *Streptomyces albosporeus 2-6* in sterile soil it lost 96 per cent in 85 days. *Sarcina lutea* was able to grow both in sterile and non-sterile soils. When, however, it was cultivated in sterile soil together with the *Str. purpurascens 3-12* strain — which is exceedingly strongly antagonistic against *Sarcina* — isolated from this soil it could no more be demonstrated even in traces on the 17th day. The number of *Escherichia coli* diminishes very slowly even in sterile soil and by the 85th day it is reduced to 3 per cent of the inoculation value. The presence of antagonistic *actinomycetes* hardly accelerated the process of decay, if at all. The self-purification of soils is a highly complicated process. The liquidation of pathogens and saphrophytes "alien" to the soil type takes place first of all on the effect of antagonists. The natural, complex saprophytic microflora may, however, inhibit the exertion of the effect of antagonists. In other cases, as if as a contrast, self-purification appears in the framework of the biocoenotic connex, on the synchronous effect of several saprophytic organisms.

Introduction

By self-purification of soils — in a narrower sense — a decay or elimination of pathogenic microbes or soil invaders is meant especially under the influence of biological factors (e.g. microbe antagonists etc.). In a wider sense, however, self-purification prevails also when the decay or annihilation of true saprophytic microbes alien to the microflora of the soil type in question occur in the soil and whose transitory appearance can be traced back only to the effect of some external factors. Although the process of self-purification is influenced by a number of factors (soil structure, water content, plant cover etc.; see Mishustin 1954) the most decisive of these is still the microbial community which is mainly responsible for the liquidation of parasites and saphrophytes alien to the soil and whose species composition may differ according to soil types or variants. As regards the character and mechanism of self-purification taking place in the individual soil types unfortunately only very few data are at our disposal at present.

In the following we intend to furnish data — on the one hand — to the knowledge of the conditions of self-purification of a rendzina variant, the so-called mull-like forest rendzina (KUBIENA 1950, SZABÓ—MARTON—VARGA—SCHÖNFELD 1962) wide-spread in Central Europe, while on the other hand we attempt to gain an insight into the mechanism of self-purification itself, at the same time.

Material and Method

The examined soil. Mull-like forest rendzina on limestone. Self-purification examinations were conducted on samples taken from a 20 cm depth of the A_H horizon: $CaCO_3$ per cent 26.6; total humus 8.0 per cent; N 0.4 per cent; P_2O_5 0.1 per cent; K_2O 0.48 per cent; Na_2O 0.11 per cent; exchangeable Ca mg/100 g 634.5; Mg 7.6; K 8.8; Na 7.3; pH/H_2O 7.53.

Isolation of antagonistic actinomycetes. On non-selective basis a great number of strains were isolated on glucose-asparagin agar (glucose 10.0 g; asparagin 0.5 g; K_2HPO_4 0.5 g; agar 15.0 g; dist. water 1000 ml, pH 6.8), on casein—glucose—agar (glucose 2.0 g; casein dissolved in 10 ml 0.1 N NaOH 0.2 g; K_2HPO_4 0.5 g; $MgSO_4$ 0.2 g; $FeCl_3$ in traces; agar 15.0 g; dist. water 1000 ml; pH 6.5—6.6), further on glycerine—arginine—agar (arginine HCl 1.0 g; glycerine 12.50 g; K_2HPO_4 1.0 g; NaCl 1.0 g; $MgSO_4$ 0.5 g; $FeSO_4$ 0.01 g; $CuSO_4$ 0.001 g; $ZnSO_4$ 0.001 g; $MnSO_4$ 0.001 g; agar 15.0 g; pH 6.9—7.1).

The isolates were inoculated to glucose—asparagin agar slants controlled for purity and subsequently, parallel with their taxonomic determination, their antibiotic efficiency was studied regarding the following test organisms: *Escherichia coli* 10 985, *Bac. subtilis* 10 987, *Serratia marcescens* 10 988, *Rhizobium meliloti* B-100, *Staphylococcus albus* 10 990, *Sarcina lutea* 10 995, *Saccharomyces carlsbergensis* 10 997, *Aspergillus niger* B-20 and *Trichothecium roseum* B-25. For the latter examinations Conn-agar modified by STAPP (1953) was used. The antagonist was cultivated in the form of "point"-colony on Conn-agar plates, then after a 5 day incubation period (at 28° C) the test organism suspended in agar media was spread toward the antagonists. Then followed a further incubation for 24 hours and the reading of the inhibiting zones.

Taxonomic identification of the antagonistic actinomycetes. As regards the determination of strains and the applied methods, here we only refer to a previous study of ours (SZABÓ—MARTON 1964) in which they were discussed in detail. It should be noted that the determination was based on direct comparison with authentic, mostly type-cultures. The description of the strains was essentially founded on the physiological, morphological and cultural features suggested in 1964 by the "Subcommittee on Actinomycetes of the International Committee on Bacteriological Nomenclature, International Association of Microbiological Societies" (SHIRLING—GOTTLIEB 1964).

Determination of the self-purification velocity of the soil. The soil cultures were prepared in 100 ml Erlenmayer-flasks. Each flask contained 20 g heat-sterilized or 20 g non-sterilized soil — previously passed through a sieve (mesh: 1 mm) — the water content of which was 29 per cent after inoculation. Inoculations were carried out with spore and cell suspensions respectively. The latter were produced by washing of agar cultures and by preparing an appropriate series of dilution. At the same time the inoculation cell number was determined with the plating method. Continuous incubation was carried out at 28° C in a thermostat and the loss of the soil sample's water content was periodically supplemented. After the expiration of a definite cultivation period 40 ml sterile tap-water was added to 2 flasks belonging to identical experimental series. The suspensions were shaken for one hour and then dilution series were prepared out of the obtained soil suspensions and out of its each grade (0.5 ml) plates were cast in Petri dishes. The medium used for these plates was "nutrient-agar" in the case of bacterium tests (pepton 10.0 g; meat extract 5.0 g; NaCl 5.0 g; glycerine 15.0 g; agar 18.0 g; dist. water 1000 ml, pH 7.0) while for actinomycetes tests it was casein—glucose agar. To determine the mean number of the germinating cells and the spreading we spread from each dilution for so many Petri dishes that the number of plates to be read off should be at least 12. The survival of authentic strains inoculated into non-sterile soil samples was determined by reisolation.

Results

Occurrence of the antagonistic actinomycetes. From this soil a total of 1 *Nocardia* and 33 *Streptomyces* species were isolated. From among the latter, 9 belonged to the *Antibioticus*, 3 to the *Cinereoruber*, 4 to *Griseoflavus*, 3 to

Albus Sterilis, 1 to *Griseus*, 2 to *Venezuelae*, 1 to *Albus*, 1 to *Flavovirens*, 1 to *Chartreusis*, 1 to *Ruber-Sterilis*, 2 to *Albosporeus*, 1 to *Viridis-Sterilis*, 1 to *Niveoruber* and 1 to the *Phaeochromogenes* series (Szabó—Marton 1962), while the serial position of 2 *Streptomyces* species could not be determined. Among the strains of the 33 *Streptomyces* species, antagonists effective against *E. coli* were found in the case of 8 species. Only the strains of 3 species exercised an inhibiting effect against *Serratia marcescens*. The number of strains active against *Sarcina lutea* was very high and they belonged to more than 23 species. Finally, the number of *streptomycetes* effective against *Aspergillus niger* was very low (the strains of hardly more than 3 species). In the activity, but also in the antibiotic spectrum of strains belonging to the same species substantial differences were sometimes observed. In this connection we present out of our material of examination the data of the antibiotic activity of 100 strains belonging to 2 different *Streptomyces* species in Table 1. It appears that the number of strains effective against *Escherichia coli* was low while among the strains belonging to the species *Str. chartreusis* there could be found ones that were inactive against *B. subtilis*, while others displayed strongly antagonistic effect.

Table 1

Distribution of antagonistic and inactive strains among the isolates belonging to two different Streptomyces species

Denomination of species	Series	Test-organisms	Number of strains examined: inactive	weak antagonistic	medium antagonistic	strong antagonistic
Str. chartreusis	*Chartreusis*	*E. coli*	78	2	—	—
		B. subtilis	66	9	1	4
Str. finlayi	*Flavovirens*	*E. coli*	19	1	—	—
		B. subtilis	12	5	3	—
		Asp. niger	19	1	—	—

Summing up our examinations concerning the occurrence of antagonists, it can be established that the studied "rendzina-moder" (mull-like rendzina, A_H horizon) was very rich in antagonistic actinomycetes of various activity and antibiotic spectrum which belonged to different species.

Self-purification experiments. a) The total number of *Aspergillus niger* inoculated into non-sterile soil samples — in spite of the fact that the amount of species actively antagonistic to this organism (at least among the *actinomycetes*) is very low — was rapidly reduced (it was no more than 0.6 per cent on the 17th day) and on the 31st day its presence could no more be observed either on nutrient or on casein—glucose agar. In the sterile soil samples employed as controls the slow reduction of the total number of *Aspergillus* was also observed but on the 85th day 28 per cent of the original number could still be demonstrated. All this seems to indicate that this soil — also in sterilized condition — ensures only moderate possibilities of multiplication for *A. niger*. Very interesting results were obtained from the experiments when *A. niger* had been cultivated in sterile soil together with the antagonistic strain *Str. albosporeus R-2-6* very effective against this organism. Table 2 presents a review of the obtained results.

Table 2

Change of relative germ number of Aspergillus niger and Str. albosporeus R-2-6 in sterile soil in the course of common cultivation for 85 days

Day of incubation	1	3	17	43	85
Aspergillus niger	100	22	17	146	4
Str. albosporeus R-2-6	100	—	758	1630	343

It appears that the demonstrable amount of *A. niger* was reduced rapidly, to 22 per cent of the inoculation number already by the 3rd day of cultivation and subsequently, as if settling down, diminished very slowly until the 17th day. In the further course of cultivation a temporary increase of significant measure could be observed although at the same time the antagonist also reached a maximum density of population. Finally, on the 85th day only 4 per cent of the original cell-amount was observed which points to the fact that ultimately the demonstrable number of *Aspergillus* still diminished to a lower level in the presence of the antagonist than in the sterile control soil, in monoculture.

b) The situation was different in the case of *Sarcina lutea* the development of which could be demonstrated both in sterile and non-sterile soils. On the 31st day of cultivation the cell number observed in the sterile control soil sample was 13 times higher and after this population maximum, on the 85th day it was still 1.6 times higher than the initial number of germs. In non-sterile soil, *Sarcina lutea* increased its cell number by 1.5 times by the 17th day. When this microorganism was cultivated in sterile soil together with the antagonist *Str. purpurascens* strain No. R-3-12 its total number diminished to 0.9 per cent already by the 3rd day of cultivation and on the 17th day, *Sarcina* was no more demonstrable.

c) The examination of the survival of *Serratia marcescens* proved to be interesting. Although only a total of 3 *Streptomyces* species were isolated the strains of which were active against *Serratia*, yet the latter had, in non-sterile soil, but a comparatively short life and from the 17th day of cultivation (0.03 per cent on the 17th day) it practically appeared only in traces, while on the 43rd day its occurrence could be no more demonstrated. In sterile soil — after an initial increase 30 — per cent of the starting cell number could be demonstrated even on the 85th day.

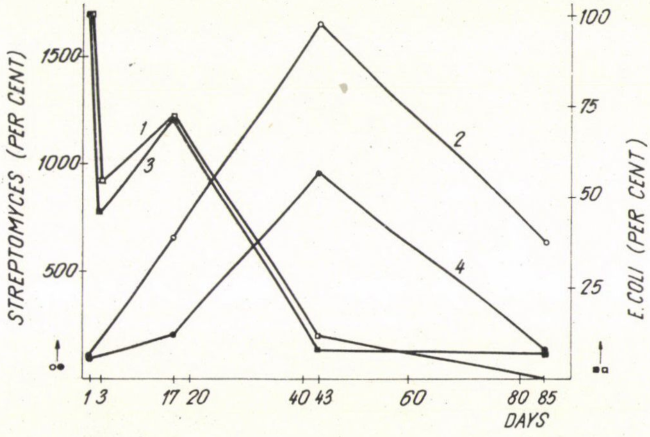


Fig. 1. The change of cell counts of *E. coli* FBUA 10 985 and of *Streptomyces* antagonists in sterile soil; 1 = *E. coli* in common culture with the strain *Str. hygroscopicus R-1-8.* 2 = The number of *Str. hygroscopicus R-1-8* in common culture with *E. coli.* 3 = *E. coli* cell count in a culture common with the strain *Str. griseolus 1-24.* 4 = The number of *Str. griseolus R-1-24* in common culture with *E. coli*

d) *Escherichia coli* showed, in sterile soil, in monoculture, after an initial strong reduction of its cell number, a slight trend of increase, the measure of which corresponded to about 20 per cent of the initial number but in the absolute sense it did no more attain the inoculation level. Subsequently a new reduction of the total number was observed but on the 85th day the organism was still demonstrable to 3 per cent. It is interesting to note that the process of the decay of *E. coli* took an almost similar course when cultivated in sterile soil together with some antagonist. In Fig. 1 two such experiments are presented. In the first one *E. coli* was cultivated together with the strain *Streptomyces hygroscopicus R-1-8* of intensive anticoli activity, while the antagonist applied in the second experiment was the strain *Str. griseolus R-1-24.* The change of the *E. coli* number showed in both experiments a completely identical picture and was similar to that of the control. The population dynamics of the antagonists — compared to each other — changed, except for the quantitative differences, also similarly. On the basis of the obtained picture we may establish that the reduction of the coli-number was not at all or hardly accelerated by the presence of the antagonists.

Interaction of the antagonists in the examined soil (a structure-coenological study). **One of the most important, still most difficult tasks of soil microbiology is to elucidate the factors or complicated interactions that, under natural circumstances, determine the quantitative occurrence on individual species, the species-composition of microflora or the character and velocity of the self-purification processes of the soil.**

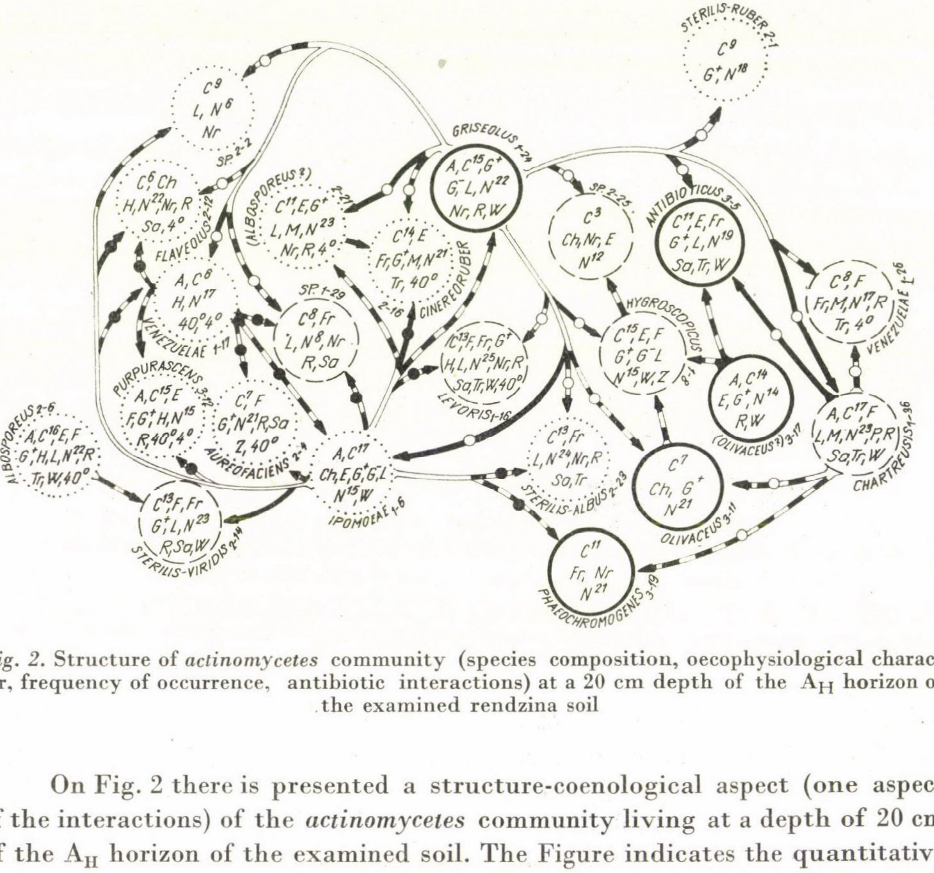


Fig. 2. Structure of *actinomycetes* community (species composition, oecophysiological character, frequency of occurrence, antibiotic interactions) at a 20 cm depth of the A_H horizon of the examined rendzina soil

On Fig. 2 there is presented a structure-coenological aspect (one aspect of the interactions) of the *actinomycetes* community living at a depth of 20 cm of the A_H horizon of the examined soil. The Figure indicates the quantitative and qualitative species composition as well as the oecophysiological character and antagonistic interactions of the species. The proportion of *actinomycetes* in the examined aspect is 65—70 per cent of the total microflora. On the Figure each circle represents a *Streptomyces* species. From the 20 cm soil depth a total of 23 species were isolated. Through the observation of the colonies developed on the plates after spreading soil suspensions and by way of subsequent study of the isolates obtained in large numbers, the approximate frequency of occurrence of the species was also determined and indicated on Fig. 2, namely: the dotted circles represent rare occurrence. (The colonies of this species could be observed and isolated but rarely.) The circles marked with broken lines indicate medium frequency of occurrence. Finally the circles drawn with continuous thick lines represent frequent or dominant occurrence. Within the circles the characters of the species studied by us are indicated with letters and numbers according to the following: It should be noted that on Fig. 2 the feature mosaic of every species is related to one concrete strain each as a typical representative of the species. In the case of each species a number of strains were examined, viz. "population analysis" was conducted. That strain was indicated as a representative of the species (and presented on Fig. 2) the feature mosaic of which represents most accurately the population of the species developed in the soil horizon; in other words what is completely or approximately identical with the majority of the examined strains belonging to the same species.

A. Antibiotic activity. A strain representative of the species in question exercised, on Na-asparaginate-agar, strong or medium inhibition against the strains of at least 13 of the 34 species isolated from this soil (the radius of the inhibitory zone was above 10 mm) C^x*:* Positive utilization of x-compounds from among the 22 C-sources studied on the synthetic basal media of Pridham and Gottlieb (d-fructose, l-arabinose, rhamnose, d-galactose, 1-sorbose, sucrose, maltose, lactose, cellobiose, raffinose, inulin, glycerine, d-mannitol, d-sorbitol, dulcitol, mesoinosite, salicin, dextrin, starch, glycogen, Na-oxalate, Na-citrate). *Ch.:* Chlamydospore formation. *E:* Proteolytic activity. The radius of the lytic zone on protein agar-plates according to Lieske is at least 10 mm. *F:* Antifungal activity. *Fr:* Resistance of the substrate mycelium to moist heat (the germination per cent of the grounded mycelium suspension after a 45° C treatment for 5 minutes in saline is still 15 per cent as compared with the non-treated control suspension. G^+*:* Inhibitory effect against Gram-positive bacteria and G^-*:* on Gram-negative bacteria. *H:* Strong haemolytic effect. *L:* Capacity to attacking fats. *M:* Melanine formation. N^x*:* Positive utilization of x-compounds from among the 25 N-sources examined on the synthetic basal media of Pridham and Gottlieb [NH_4Cl, $(NH_4)_2CO_3$, NH_4NO_3, $(NH_4)_2SO_4$, urea, glycine, dl-alanine, dl-valine, dl-norvaline, dl-serine, dl-threonine, cysteine, l-cystine, dl-methionine, l-arginine, dl-lysine, dl-aspartic acid, l-asparagin, l-glutamic acid, l-tyrosine, dl-tryptophan, l-histidine, nucleic acid, peptone, trypton]. *Nr:* Ability to reduce nitrates. *P:* Paraffin utilization. *R:* Resistance to antibiotic effects. It is inhibited by the strains of no more than 8 other species, isolated from this soil, with high or moderate activity. (The radius of the inhibition zone is larger than 10 mm on Na-asparaginate agar.) *Sa:* Increased salt tolerance. Good development in glycerine-asparagin-liquid culture (6) in the case of all following salt concentrations: $NaNO_3$ 8 per cent; NaCl 7 per cent; $(NH_4)_2SO_4$ 15 per cent; $MgSO_4 \cdot 7H_2O$ 25 per cent; $Na_2SO_4 \cdot 10H_2O$ 25 per cent; $Na_2S_2O_3 \cdot 5H_2O$ 14 per cent; KJ 4 per cent;

NH_4Cl 4 per cent. *Tr:* Resistance of substrate mycelium to dry heat. In an air-dry state the mycelia tolerates a heat-treatment at 97° C for 15 minutes. *W:* Positive wax utilization. *Z:* ability to decompose cellulose. *40° C:* normal growth at 40° C or above this value. *4° C:* growth at 4° C or below this value.

In addition to this, on Fig. 2 arrow-systems starting from the circles can also be seen demonstrating the most important antibiotic relationships. The arrows are directed from the antagonist towards the sensitive organisms. The black arrows represent intensive while the cross-striped arrows medium inhibitory effect on Na-asparaginate agar. The small circles marked on the arrows inform us on how far we may reckon with the inhibitory effects under natural soil conditions. The inhibitory effects that could be induced also with the sterile, filtered aqueous extract of the soil monocultures of antagonists (hole-test method) were marked in every case with a little circle on the arrow; in the case of empty circles the soil culture — in wich the antagonist was cultivated — was enriched with 1 per cent glucose, while in the case of black circles it was not. As to the methods of the examinations referred to, see for details Szabó *et al.* (1962b).

Fig. 2 readily illustrates that there are considerable differences in the physiological activity of the various species. These differences, however, do not explain automatically the frequency of the occurrence. Thus e.g. the physiological activity of species *Str. olivaceus 3-11* or *Str. phaeochromogenes 3-19* is rather low, still these organisms are common in the microflora. On the other hand, species *Str. flaveolus 2-12*, *Str. albosporeus* (?) *2-21* and *Str. ipomoeae 1-6* etc. with a considerable metabolic potential are only sporadic floral elements. Even the antibiotic activity does not supply satisfactory information in this respect. Undoubtedly species *Str. griseolus 1-24*, a very strong antagonist being capable — at least in a soil enriched with glucose —, of antibioticum production, is simultaneously a dominant floral element but at the same time the occurrence of the very effective species *Str. ipomoeae 1-6* producing antibioticum even in unenriched soil could be demonstrated only sporadically.

Discussion

The results of our investigations have revealed that the decay of pathogenic or saprophytic microorganisms alien to the soil can be substantially accelerated by the presence of the soil microflora. The process itself, however, is exceedingly complicated and it is very probable that in the presence of the natural microflora of untreated soils in numerous small microhabitats of the soil, the liquidation of obligate parasites, soil inhabitants and invaders, etc. is carried out at the same time by various antagonists according to the most different mechanisms, since — as we have seen — the spreading or occurrence of the individual antagonists themselves is limited. Thus e.g. although the presence of the strain *Str. purpurascens R-3-12* as an exceedingly strong anti-Sarcina antagonist could be demonstrated from the examined soil, still *Sarcina lutea* was able to develop also in the presence of the natural microflora which points to the fact that growth and antagonistic activity of *Str. purpurascens* in the soil were considerably limited. In fact the interaction of species in natural soils, the dynamics of the mass relations of their populations, the disappearance of some species and the appearance of others are such complicated and hardly analysable processes that their understanding and elucidation can be carried out — even in model experiments — only with great difficulties or in some cases not at all. Beside the biological factors inducing self-purification also abiotic factors attributable to the physicochemical conditions of the soil play an important part which practically manifests itself in the fact that in sterile soil samples exceedingly rapid decay of some organisms can also be observed. Anyway, the special abiotic environmental conditions of the individual soil types and the specific autochthonous microfloras living in these soils realize the process of self-purification in a complicated interaction, in a way characteristic of the soil type, as it has recently been demonstrated by Unger and Wagner (1965) in connection with the enteropathogenic serotypes of *E. coli*.

REFERENCES

Kubiena, W. (1950): Bestimmungsbuch und Systematik der Böden Europas. Ferdinand Enke Verlag, Stuttgart. 1—392.

Mishustin, E. N. (Мишустин, Е. Н.) (1954): Микроорганизмы и самоочищение почвы. Москва. Изд-во Акад. Наук СССР. 1—656.

Shirling, E.—Gottlieb, D. (1964): Methods Manual. International Cooperative Project for Description and Deposition of Type Cultures of *Streptomyces*. Ohio, Delaware, 1—27.

Stapp, C. (1953): Untersuchungen über Actinomyceten des Bodens. I. Zbl. Bakt. II. **107**, 129—150.

Szabó, I.—Marton, M. (1962a): Beitrag zur Systematik der nicht verticillaten *Streptomyces*-Arten. Zbl. Bakt. II. **115**, 380—393.

Szabó, I.—Marton, M. (Сабо, И.—Мартон, М.) (1962b): О биоценотическом положении вида *Actinomyces levoris* в карбонатно-перегнойной почве. Микробиология, **31**, 884—890.

Szabó, I.—Marton, M.—Varga, L.—Schönfeld, S. (Сабо, И.—Мартон, М.—Варга, Л.—Шёнфелд, Ш.) (1962): Комплексные почвенно-биологические исследования на рендзинах. Почвоведение, **10**, 85—95.

Szabó, I.—Marton, M. (1964): Zur Frage der spezifischen Bodenmikrofloren. Ein Versuch zur systematischen Bestimmung der Strahlenpilzflora einer mullartigen (Wald-) Rendsina. Zbl. Bakt. II. **118**, 265—306.

Unger, H.—Wagner, M. (1965): Das Verhalten enteropathogener Serotypen von *Escherichia coli* in zwei verschiedenen Böden. Modellversuche mit Hilfe der makroskopischen Immunfluoreszenzmethode. Zbl. Bakt. II. **119**, 474—489.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 47—59 (1968)

SOME OBSERVATIONS ON PISTIL ORGANIZATION OF HERACLEUM MANTEGAZZIANUM (SOMM. ET LEV.)

By

A. Kovács, S. Sárkány

INSTITUTE FOR APPLIED BOTANY AND HISTOGENETICS, L. EÖTVÖS UNIVERSITY, BUDAPEST

Pistil organization of the said species has been examined on serial sections of flower primordia in various stages of development. Initiating at first in full independence from one another, the protuberances of pistils, stamina and petals were found to develop subsequently by means of congenital concrescence (appendicular organization), whereas the septum that separates the ovary is formed in the stage of plication by postgenital concrescence, the leaf edges getting rolled up. The test results fail to prove the real inferiority of the ovary, and so the more since the homogeneous vascular system of the pistil wall also suggests a foliaceous character.

Introduction

As shown by the large number of papers written on reproductive organs, the conditions of organization of what is termed "inferior ovary" are a matter of major interest in this field. Earlier and recent data demonstrate alike the opposition of two different opinions in this respect. One of them (Schleiden 1837, Hofmeister 1868, Célakovsky 1874, Goebel 1905, Saunders 1925, Smith 1942, Samjatnin 1951 — cit. Sárkány 1962 —, Tiagi 1955, Douglas 1957) suggests that — besides the carpel tissues bordering the ovary — there is also a peripheral histological region of axial origin taking part in the construction of the wall of the ovary and of the fruit, respectively. According to the other opinion (de Candolle 1827, Lestiboudois 1854, Van Tieghem 1875, Velenovsky 1904, 1910, Bechtel 1921, Leinfellner 1940, McCoy 1940, Eames 1931, 1947, Kaden—Tihomirov 1954, Takhtajan 1959, Sárkány 1962) the ovary wall is formed not only by the carpels, but also by the congenitally interlaced basal parts of the perianth and stamen leaves. Suggesting a transition between the two conceptions, there are some authors (Baum 1949, 1950, Perwuchina 1950, Alexandrov—Perwuchina 1952) who regard the basal part of the peripheral tissues of the ovary wall as being of axial origin, and its upper part as uniformly interlaced formations of perianth, stamen and carpels. Others (Mohl 1863, Gray, La Maout, Deacaisne cit. Jackson 1934) regard — as far as the *Umbelliferae* are concerned — only the central septum as being of axial origin.

Since contradictory opinions are still maintained even in our days not only in regard to different families but also within one or the other of them, it seemed advisable to study the question within one family, relying upon separate and detailed histogenetical examination of several species and taking into consideration the different stages of pistil organization.

Since our Institute has worked already on the formation of the ovary and pistil of *Foeniculum vulgare* (SÁRKÁNY 1962) belonging to the family of *Umbelliferae*, we have started, by way of continuation, a new series of examinations on several species of that family, including *Heracleum mantegazzianum* (Somm. et Lev.). The present paper describes our observations on the pistil organization of this species.

Material and Method

The material for histological analysis was gathered from inflorescences of various stages of development in the taxological garden of the Botanical Research Institute, Vácrátót, in two consecutive years (1964, 1965).

The flower primordia of various ages as well as the full-blown flowers were fixed for 2—4 hours in Bouin's fixative and kept in 70 per cent alcohol after elution. The paraffin embedding technique was used for the microtechnical operations. Serial sections of cca. 12—15 μ were made on a Reichert-type slide microtome. The sections were stained partly with vesuvine and partly with Ehrlich's acid hematoxylin.

Examinations and Results

Characteristical irreversible changes occur during the transition of the vegetative shoot apex into the reproductive inflorescence stage. Divided into meristematic zones, the vegetative cone is submitted to a considerable increase of volume; arranged in a centripetal pattern, the protuberances of umbels soon appear on the centripetally formed compound umbellate inflorescence primordium, and all of the protuberances are finally organized into flower primordia.

After the primordia have become flat, the protuberances of petals and stamina are differentiated, and by the time they have attained a certain stage of development, the apical initiation of the two carpel primordia also begins (Fig. 1). In the cells of the subprotoderma mitotic divisions can be observed (Fig. 2) in centripetal sense. The initial cell groups of the pistil primordium are formed of the cells of the external layer of those two layers resulting from periclinal divisions. As early as in the initial stage a slight swelling can be observed on the place of the two carpels, as a result of divisions taking place in the initial cell group, as well as in some cells of the adjacent third and the following (fourth) cell row (Fig. 3). For a while, the upper cells make in a periclinal-anticlinal way (Fig. 3) for the apical growth of the two carpel protuberances, while the lower ones secure subsequently the intercalar growth by divisions with diagonal partitions.

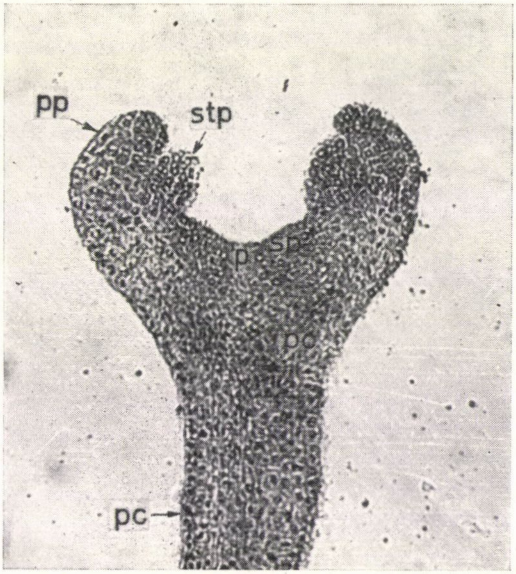


Fig. 1. Radial longitudinal section of flower primordium. Petal primordium (pp), stamen primordium (stp), protoderm (p), subprotoderm (sp), procambium (pc), peduncle (pe). Oc.: 6.3. Obj.: 6.3

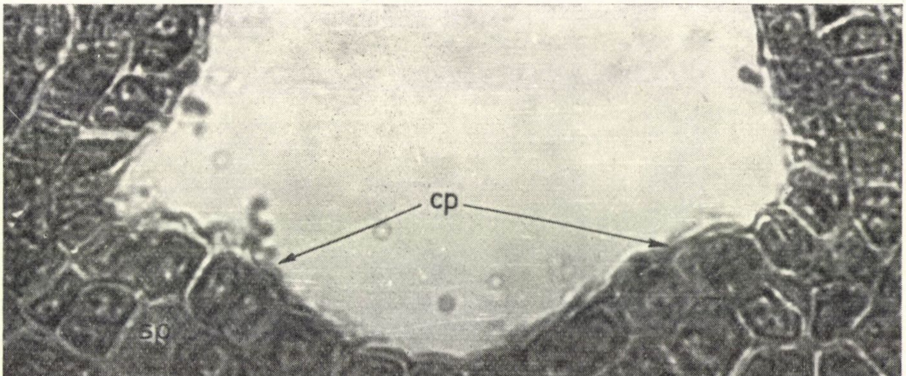


Fig. 2. Initial organization of carpels of flower primordium, longitudinal section. Carpel primordium (cp), protoderm (p), subprotoderm (sp) with mitotic divisions of periclinal character, stamen primordium (stp). Oc.: 6.3. Obj.: 40

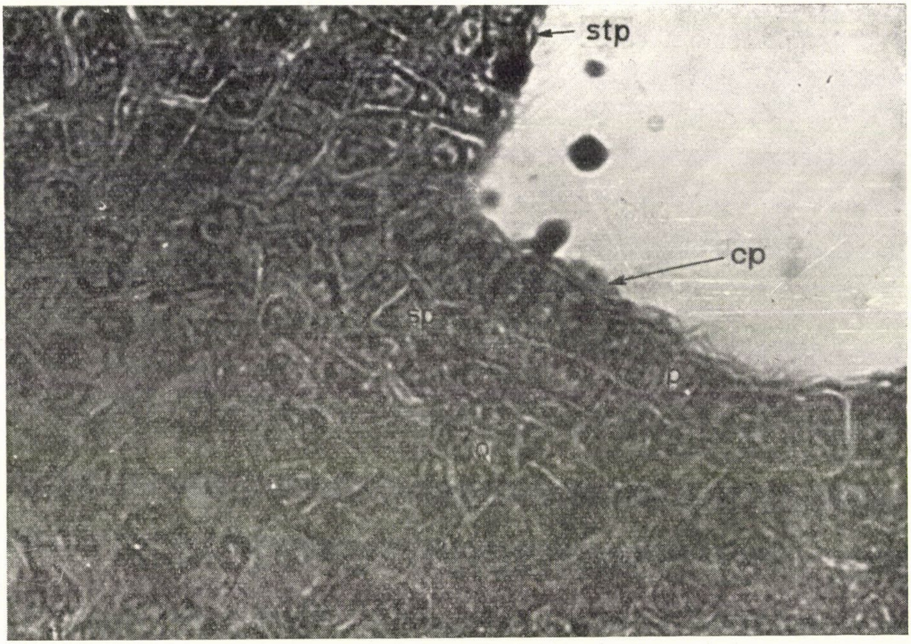


Fig. 3. Apical organization of carpel primordium, longitudinal section (cp). Protoderm (p), division of periclinal-anticlinal type at derivates of the subprotoderm (sp), divisions in the third and fourth cell rows (o), stamen primordium (stp). Oc.: 6.3. Obj.: 40

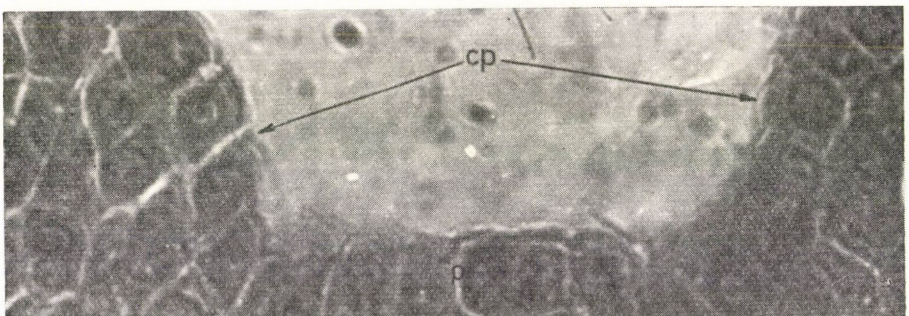


Fig. 4. Organization of cross zone (h), longitudinal section. Carpel primordium (cp), protoderm (p). Oc.: 6.3. Obj.: 40

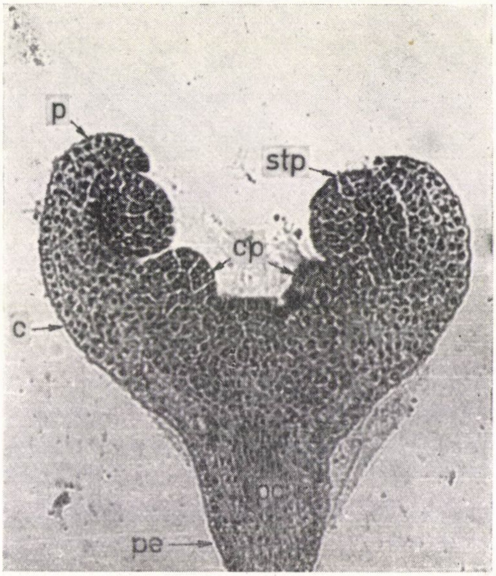


Fig. 5. Radial longitudinal section of flower primordium in the course of the apical organization of carpel primordia (cp). Stamen primordium (stp), developing petal (p), congenital organization of basal parts (c), procambium (pc), peduncle (pe). Oc.: 6.3. Obj.: 6.3

Following the apical development, the initials of the "rudimentary" cross zone are being developed by divisions with periclinal walls in the third layer of the meristematic zone between the two carpel primordia spatially detached so far (Fig. 4). From now on, the young gynaeceum is growing with congenital concrescence in a basiplastic way, with the basal parts of stamina and petals also taking part (Fig. 5). Accordingly, an appendicular origin may be suggested. The hose-like formation of the base of carpel primordia is not distinct, since the hardly noticeable increase of the cross zone is by far inferior to the growth of the dorsal sides; in fact, it stops before long. It is thus a matter of latent peltation.

In the early phase of the plication stage the apical growth of the carpel primordia is assumed by the bisectionally segmented initial in the subapical layer (Fig. 6). Upon the action of the peripheral meristema the carpel primordia start quickly growing while widening in centripetal sense too. In doing so, their apices come nearer to one another and their edges get rolled up. The rolling up appearing most vigorously at the base, is expanding from there towards the apex.

Bending inwards and touching each other, the edges of the young carpels are postgenitally interlaced by their abaxial side in the lower zone (Fig. 7). The organization of the developing gynaeceum is here of a syncarpous character. In the upper zones there is only a single cavity to be observed, in fact, there

Fig. 6. Apical growth of plication stage, longitudinal section. Carpel primordium (cp), bisectionally segmented initial (i), protoderma (p). Oc.: 6.3. Obj.: 40

is no contact between the incurving carpel edges in the neighbourhood of the apex.

In the course of further organization, plication is continued by the carpel apices bending always closer to one another; finally, they meet. As a result, postgenital concrescence takes place in the apical region too (Fig. 8). Two thirds of the septum develop in this way, rising above the level of separation of stamina and petals. The pertinent longitudinal section clearly shows that the plication phase has not yet come to an end, but that the organization of two ovules per cavity has already begun on the upper part of the partition. At the beginning the nucellus of both pairs of seed initials develops at almost the same intensity (Fig. 8). The development of the only integumentum soon begins, but cannot be noticed in each cavity but on the ovulum of lower posi-

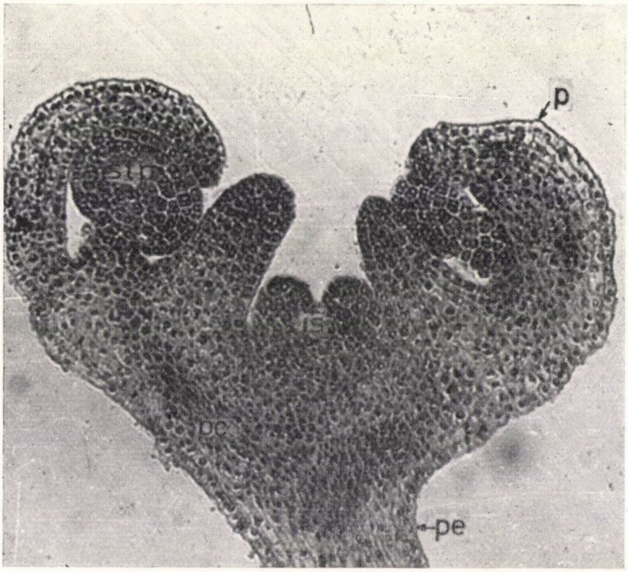


Fig. 7. Radial longitudinal section of flower primordium in early stage of plication. Growing petal (p), stamen primordium (stp), rolling up and postgenital concrescence of leaf edges in the basal zone (ls), procambium (pc), peduncle (pe). Oc.: 6.3. Obj.: 6.3

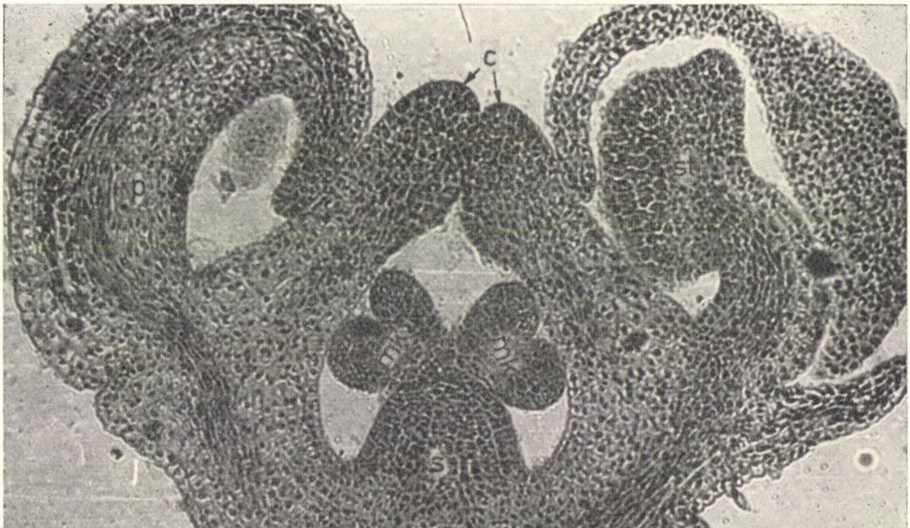


Fig. 8. Radial longitudinal section of flower primordium in the plication stage. Petal (p), stamen (st), carpel apices (c), growing septum (s), developing obules (mk), vascular bundle (sz). Oc.: 6.3. Obj.: 6.3

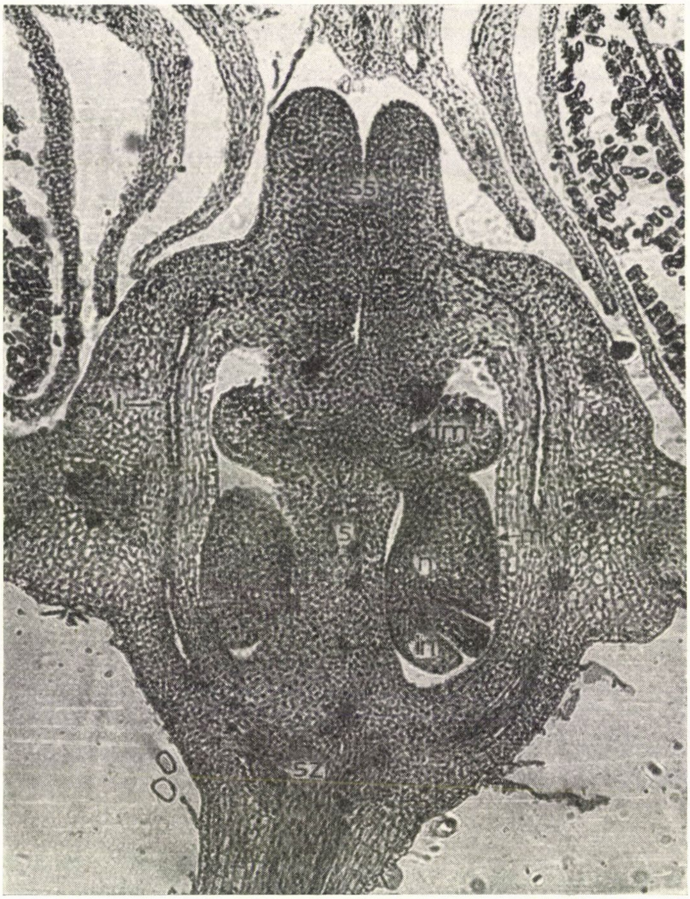


Fig. 9. Radial longitudinal section of a young flower's gynaeceum after the end of the plication stage. Growing style (ss), septum (s), ethereal oil duct (i), vascular bundle (sz), backward ovule (mk), further organized ovule integumentum (in), nucellus (n). Oc.: 6.3. Obj.: 6.3

tion and not on the upper ones which remain sterile; the lower ones are soon differentiated into extrorse anatropic fertile ovulum (Fig. 9). The plication phase of pistil organization running in parallel is finished only in the course of macrogametogenesis. Together with other flower regions the ovary wall continues to increase congenitally — mainly in intercalate way — and there commences the full development of the different tissues (e.g. vascular bundles and ethereal oil ducts). At the same time, the longitudinal growth of the two styles and the development of the discus make rapid progress. As a result of these processes, the distance between the separation level of stamina and petals continues to grow, and the size of the ripe pistil region of complex histological structure corresponds to three quarters of that of the future fruit.

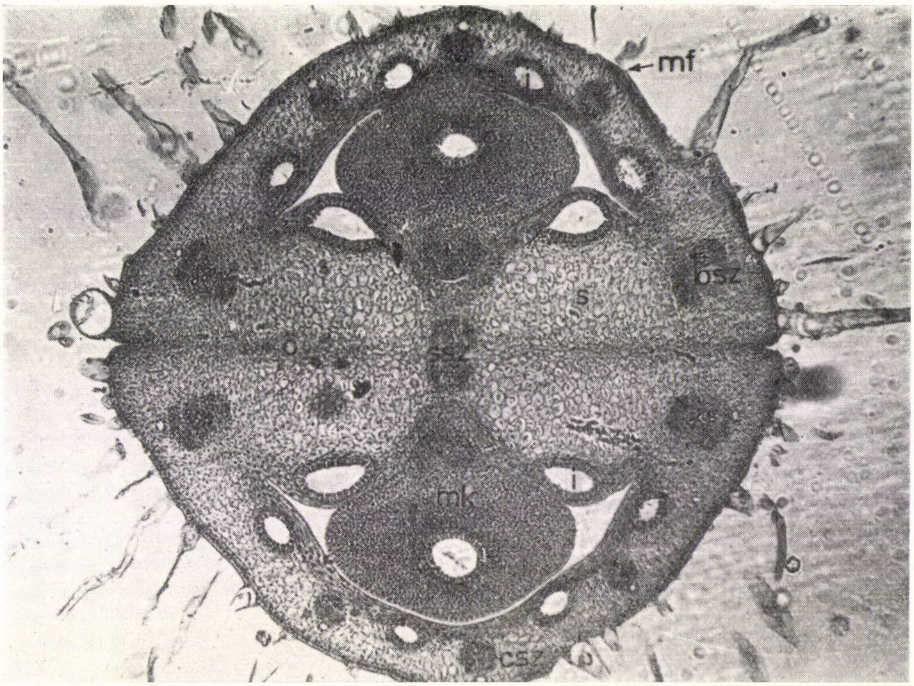


Fig. 10. Cross-section of mature flower. Ovary wall (mf), septum (s), concrescence of carpel edges (ö), ovule (mk), bicollateral (bsz) and collateral vascular bundles (csz), vascular bundles of septum (ssz), ethereal oil duct (i). Oc.: 6.3. Obj.: 6.3

Even at this stage of growth the place of concrescence in the septum can clearly be noticed on the cross-section of the ovary (Fig. 10).

As far as the gynaeceum of *Heracleum mantegazzianum* is concerned, the typical appendicular organization seems to be demonstrated by the aforegoing findings, supported by the homogeneous character and course of the vascular bundles which, on the basis of cross-section series of the fully developed flower, may be characterized as follows. In the peduncle there are four collateral open vascular bundles to be observed (two smaller ones facing two larger ones), which meet near the node like a ring, then ramify above the nodal level in the basal zone of the flower and continue in as many as fourteen bundles. Ten of these bundles — five on each side — run in the peripheral part of the complex ovary wall (of heterogeneous origin), while the remaining four are sited in the septum. From among the ten bundles, the two opposite pairs that are nearest to the septum present a structure of biocollateral character, while the remaining six are of collateral organization. This arrangement can be followed as far as the zone below the level of separation of stamina and petals. From this level on, there are alternating ramifications into stamina and petals, while the proper bundles of the pistil, touching one another, proceed in form of a

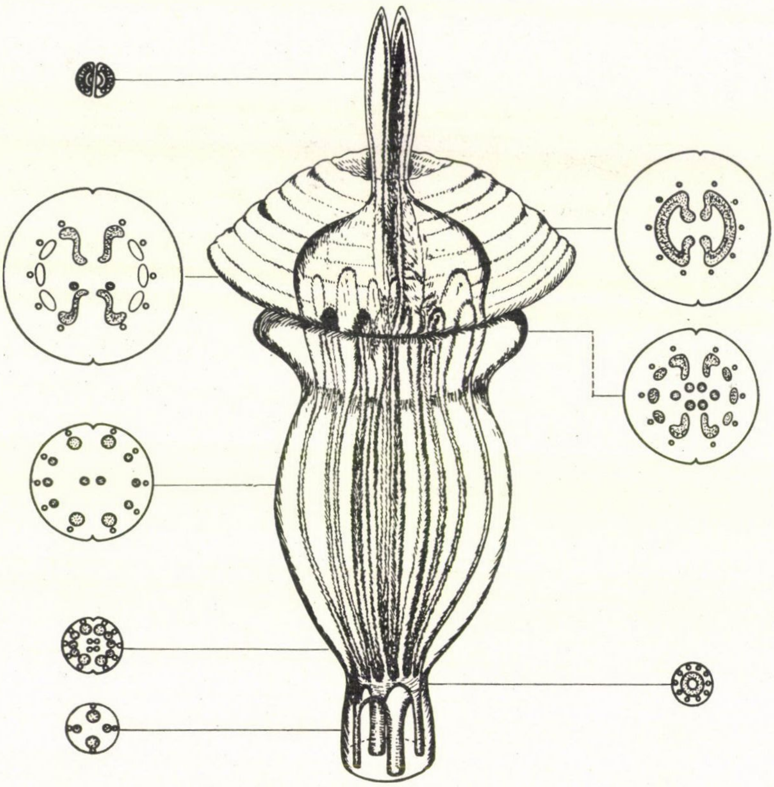


Fig. 11. Spatial scheme of the vascular tissue system of the pistil, cross-sections represented from the level of various zones. Linear amplification: 12 : 1

horseshoe (spatially in two half cylinders) according to the two carpels with gradual decrease of volume as far as the apex of the style. Fig. 11 shows the schematic spatial arrangement of the forwarding bundles referred to.

The bundles running in the septum fuse by twos at the level of the ovary's basal part, and become — further above — independent bundles, so as to continue either as bundles of the ovule or those of the style; the latter ones being absorbed in the other bundles.

Discussion

As a result of our examinations, the organization of the pistil of *Heracleum mantegazzianum* (Somm. et Lev.) may be qualified as foliaceous, suggesting thus the appendicular origin of the ovary wall. Apical initiation of the two carpel primordia begins in the subprotoderma divided by the periclinal wall, while the marginal increase of the pistil primordium results from the activity of the peripheral meristema; its development is thus homologous to the organization of the leaf. Our results are consistent with the findings of McCoy (1940), who has found in every floral part of *Frasera caroliniensis* to be formed like leaves by periclinal divisions of the internal "tunica layer". It was also in the second cell row of the "tunica" where Petri—Szentpétery (1960) first noticed periclinal divisions in the course of pistil organization of *Datura stramonium*. We cannot agree with the opinion of Grégoire (1931) who considers the pistil of *Angiospermae* as an organ "sui generis". He justifies his opinion by denying having observed other than longitudinal growth in the development of the pistil. However, this is refuted, among others, by the test results described above and by the publication of Petri—Szentpétery (1960) where the increase of the carpels by the marginal meristema is emphatically stressed.

Subsequent to apical development, the organization of latent peltate and of typical plicate zones proves equally the purely foliaceous character of the ovary wall. Similar data can be found in the morphological works of Troll (1931), Leinfellner (1950) and in the histogenetical works of Petri—Szentpétery (1960) and Leinfellner (1941).

In the course of our examinations the appendicular character of the developing ovary has been established. At the beginning of peltation (at the division of "transversal zone" initials) the congenital concrescence of the basal part of every petal initial can be concluded upon. On the other hand, the vascular bundles developed in the pistil wall constitute a homogeneous system and none of them can be regarded as having an axial character. These bundles are the common bundles of carpels, stamina and petals, and the septum bundles of the carpels, respectively. Our results on the course of the vascular bundles agree with earlier findings (Van Tieghem 1868, 1871; Velenovsky 1904, 1910); as well as with recent publications (Eames 1931, 1947; Takhtajan 1959, Sárkány 1962).

On the ground of the aforesaid it can be stated that the wall of the ovary is of homogeneous organization, developing with a common system of bundles from the congenitally developing leaf bases of the three floral regions and no tissues of axial origin can be detected therein; consequently there is no question of the ovary being sunk into the flower receptacle. Accordingly, we cannot agree with opinions regarding the ovary of *Heracleum* either as inferior or as half-inferior (Alexandrov—Perwuchina, 1952). Referring also to examinations of *Foeniculum* (Sárkány, 1962) we are of the opinion that this type of pistil organization must be definitely regarded as a progressive phenomenon.

Acknowledgement

We avail ourselves of the opportunity to express our gratitude to the laboratory assistants Mrs. József Huszár and Mrs. Adorján Hegyi for their valuable cooperation in microtechnical and photographical works.

REFERENCES

Alexandrow, W. G.—Perwuchina, N. W. (Александров, В. Г.—Первухина, Н. В.) (1952): К физиологической трактовке структурного развития завязи и плода зонтичных (на примерах **Heracleum** и **Skandix**) Труды Бот. Инст. им. В. Л. Комарова, АН СССР, 7, 1—47.

Baum, H. (1949): Der einheitliche Bauplan der Angiospermengynaezeen und die Homologie ihrer fertilen Abschnitte. Österr. Bot. Zt., **96**, 64—82.

Baum, H. (1950): Lassen sich in der Ontogenese der Karpelle und Staubblätter noch Anklänge an ihre phylogenetische Entwicklung aus Telomen feststellen? Österr. Bot. Zt., **97**, 33—34.

Bechtel, A. R. (1921): The Floral Anatomy of the *Urticales*. Amer. Jour. Bot., **8**, 386—410.

Candolle, A. P. De (1827): Organographie végétale. Vol. 1. Paris.

Célakovsky, L. (1874): Über die Cupula und den Cupularfruchtknoten. Österr. Bot. Zeitschr., **24**, 358—370.

Douglas, G. E. (1957): The Inferior Ovary. Bot. Rev., **23**, 1—46.

Eames, A. J. (1931): The Vascular Anatomy of the Flower with Refutation of the Theory of Carpel Polymorphism. Amer. Jour. Bot., **18**, 147—188.

Eames, A. J.—Mac Daniels, L. H. (1947): Introduction to Plant Anatomy. 2nd ed., New York.

Goebel, K. (1905): Organography of Plants. Part II. (Engl. transl. by I. B. Balfour).

Grégoire, V. (1931): La valeur morphologique des carpelles dans les Angiospermes. Bull. Acad. Belgique V., **17**, 1286—1302.

Hofmeister, W. (1868): Allgemeine Morphologie der Gewächse. 1. Bd. 2. Teil, Handbuch der physiologischen Botanik. Leipzig.

Jackson, G. E. (1934): The Morphology of the Flowers of Rosa and Certain Closely Related Genera. Amer. Jour. Bot., **21**, 453—466.

Kaden, N. N.—Tihomirov, V. N. (1954): Zum Problem der Morphologie des Fruchtknotens und der Frucht der Doldenblütler. Bjul. Moskov. OBSC. Ispyt. Prir. N. S. Otel. Biol., **59**, 79—83.

Leinfellner, W. (1941): Über den unterständigen Fruchtknoten und einige Bemerkungen über den Bauplan des verwachsungblättrigen Gynoeceums an sich. Bot. Archiv., (Lepzig) **42**, 1—44.

Leinfellner, W. (1950): Der Bauplan des synkarpen Gynoezeums. Österr. Bot. Zeitschr., **97**, 403—436.

Lestiboudois, Thém. (1854, 1855): Carpographie anatomique. Ann. Sci. Nat. IV. Bot., **2**, 223—243, **3**, 47—72.

McCoy, R. W. (1940): Floral Organization in *Frasera caroliniensis*. Amer. Jour. Bot., **27**, 600—609.

Mohl, H. (1863): Eine kurze Bemerkung über das Carpophorum der Umbelliferen Frucht. Bot. Zeit., **21**, 264—266.

Perwuchina, N. W. (1950): Über die phylogenetische Bedeutung einiger Merkmale des Fruchtbaus der Umbelliferen. Arbeiten d. Botan. Inst. an d. Akad. d. Wiss. der UdSSR, Serie **7**, 82—120.

Saunders, Edith R. (1925): The Inferior Ovary. New. Phyt., **24**, 179—185.

Sárkány, S. (1962): Organisation des Stempels und der Spaltfrucht von *Foeniculum vulgare* Mill. und die Frage des sogenannten unterständigen Fruchtknotens. Ann. Univ. Sci. Budapestiensis, Sect. Biol. **5**, 193—224.

Schleiden, J. M. (1837): Einige Blicke auf die Entwicklungsgeschichte des vegetabilischen Organismus bei den Phanerogamen. Wieg. Archiv. Nat., **1**, 289—520.

Smith, F. H.—Smith, E. C. (1942): Anatomy of the Inferior Ovary of *Darbya*. Amer. Jour. Bot., **29**, 464—471.

Takhtajan, A. (1959): Die Evolution der Angiospermen. Jena.

Tiagi, Y. D. (1955): Studies in Floral Morphology. II. Vascular Anatomy of the Flower of Certain Species of the *Cactaceae*. Jour. Indian Bot. Soc., **34**, 408—428.

TROLL, W. (1931): Beiträge zur Morphologie des Gynaeceums. Planta, **14**, 1—18.
VAN THIEGEM, P. (1868): Recherches sur la structure du pistil. Ann. Sci. Nat. V. Bot., **9**, 153—226.
VAN THIEGEM, P. (1871): Recherches sur la structure du pistil et sur l'anatomie comparée de la fleur. Mém. des savants étrangers à l'Institut. II., **21**, 1—261.
VAN THIEGEM, P. (1875): Recherches sur la structure du pistil et sur l'anatomie comparée de la fleur. Mém. Acad. Sci. Inst. Imp. France, 1—261.
VELENOVSKY, L. (1904): Die gegliederten Blüten. Bot. Zentrbl., **16**, 289—300.
VELENOVSKY, J. (1910): Vergleichende Morphologie der Pflanzen. III. Teil, Prag.
VERZÁR-PETRI, G.—BARANYAI-SZENTPÉTERY, G. (1960): Beiträge zur Entwicklungsgeschichte des Gynäzeums von *Datura stramonium* L. Acta Biol. Acad. Sci. Hung. **11**, 155—174.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 61—69 (1968)

THE EFFECT OF THE AGE OF COWS ON THE MILK PROTEIN AND CASEIN CONTENT

By

Z. SASVÁRI

DEPARTMENT OF FORAGE AND DAIRY FARMING, UNIVERSITY OF AGRICULTURAL SCIENCES, GÖDÖLLŐ

Changes in the milk protein and casein content as affected by the age of the cow have been examined in Hungarian spotted × Jersey crosses of the various aged F_1 (50 per cent Jersey blooded progeny of pure Jersey bulls out of Hungarian spotted cows) and R_1 cows (progeny with 25 per cent Jersey and 75 per cent Hungarian spotted blood by F_1 Hungarian spotted × Jersey bulls out of Hungarian spotted cows). From the data of the progeny groups I could determine that the average milk protein and casein percentages of lactation reduced slightly with the advancing age of the cow. In my own experiment the protein content was reduced by 0.18 and the casein content by 0.09 per cent between the Ist and IVth lactations.

Introduction

It should be mentioned that during the period of examination due to the fodder lack caused by the unusual drought of the previous summers the protein content of the milk of the crossed stock did not reach the genetically expectable level (especially those of the Pécs and Városföld herds) in 1962/63 and in 1963/64.

Several authors have examined the effect of the age of cows and consequently the effect of the number of lactations on the milk protein and dry matter content. According to POLITIEK (1956), English researchers demonstrated a lower fat-free dry matter content in the milk of older cows. On the basis of lactation averages VANSCHOUBROEK (1963) compared the protein percentages of the milk of cows grouped according to age. His correlative and regressive calculations resulted in a slight difference (0.0792 per cent). AURIOL—GROSSCLAUDE (1960) discovered that individually the protein content of the milk had hardly changed during the first three lactations and only slightly reduced afterwards. According to BAILEY (1952) the fat-free dry matter content reduces by 0.36 per cent with advancing age and WAITE (1955) holds that it reduces by 0.23 per cent. ROKITZKY (1959) made similar observations when he found a higher fat-free dry matter content in the milk of cows calving for the first time than in the milk of older cows. EDWARDS (1958) found that the number of milk samples having a fat-free dry matter content below 8.5 per cent which reached 23.2 per cent at 4 years of age rose to 56 per cent or even higher at 9 years. In other experiments WAITE—WHITE—ROBERTSON (1956) discovered a 34 per cent reduction from the Ist to IXth lactations and a disproportionate shift was experienced in the composition of the fat-free dry matter content. WAITE and his colleagues hold that as the cow ages the protein content decreases and the milk yield increases from the Ist to the IVth lactations. According to SMITH (1962) the fat-free dry matter content reduces by 0.21 to 0.45 per cent through 7 lactations. VOIGTLÄNDER (1964) examined the effect of age on certain components of milk in the Ist—VIIth lactations of black spotted cows. The percentage values of the various components of milk reduce to different extents with the advance of age. In a reducing order protein or fat-free dry matter content occupies the IIIrd or IVth place respectively after ash and fat among the different components. He stated that it was not necessary to make allowances for these components according to the age of the cows. POLITIEK (1956) found in his own experiments a slight reduction in the fat-free dry matter content according to advancing age, but the cause of this was primarily due to the reduction of milk sugar. KIERMEIER—PROBST (1962) are of a similar opinion: accordingly the comparison of the protein content of the milk of different age groups of progeny indicated that the effect of age was negligible. The difference did not exceed 0.10 per cent of protein.

According to researchers a comparison of the mean protein percentage of lactation of the milk of cow groups differing in these properties shows that age generally has a negligible effect or results only in a slight reduction.

Material and Methods

The bull progeny groups used in the experiment have come from the Hungarian spotted × Jersey cow stock of three state farms. The cows of these groups were of different ages. In forming the groups I tried to include enough individuals of each age for the examination. I was, however, only partially successful. The cows in the individual age groups calved at different times and thus it is conceivable that certain seasonal effects and the mentioned poorer forage influenced the formation of mean values of milk protein and casein content. Since this effect appeared in all age groups we can, in my opinion, ignore this source of error.

Fifty per cent of the examined cows of Városföld and Pécs crossed stock and 25 per cent of Mezőhegyes stock were of Jersey blood.

In order to determine the milk protein and casein content I took at the time of the official monthly test milking samples from every milking on a particular day. During the lactation I examined 9—10 samples per cow. I calculated the mean percentage or mean values on the basis of the milk protein and casein production of lactation.

I have used SCHULZ' improved formol titration method as reported by KETTING (1957) in order to determine the milk protein content; and the PEROWA formol method modified by GORBATSCHEWA to determine the casein (INICHOW 1959).

Results and Discussion

According to literature the changes caused by the cow's age in milk protein and casein content are slight.

The examined animals from the F_1 stock of Városföld were the offsprings of three Jersey bulls with 18, 37 and 14 offspring respectively. Within the particular groups the individuals were of different ages. The offsprings of the bull Feri 61 were mostly in the fifth, those of Dani 96 in the fourth and fifth while those of Cézar in the first and second lactations. The F_2 stock here consisted of 16 cows originating from 2 bulls. From their data of production the mean values and standard deviations were calculated.

Tables 1 and 2 show the distribution of cows per bull, their mean values and standard deviations in reference to the protein and casein quantity produced during lactation and Tables 4 and 5 give these in relation to the percentage values of the milk components. If we examine the mean values of the milk protein and casein quantities produced and the percentage values we see that there are significant differences primarily in the former ones between bull progeny groups and between lactations. Parallel with the increase in the number of lactations and together with the increase of milk quantity this is a regular phenomenon.

Table 1

Mean values and standard deviations of the milk protein and casein production during the lactation of the progeny groups of the 50 per cent Jersey cows (F_1) of Városföld per lactation

Sire	Lactation	Milk protein kg			Casein kg		
		n	$\bar{x}$	s	n	$\bar{x}$	s
Feri 61	2	4	128.3	12.7	4	98.8	8.9
	3	1	135.1	—	1	111.7	—
	4	1	128.0	—	1	101.1	—
	5	8	143.5	27.5	8	112.5	20.3
	6	4	140.7	13.2	4	109.0	9.3
Dani 96	1	2	81.9	—	2	65.4	—
	2	1	119.9	—	1	95.1	—
	3	2	133.5	—	2	107.6	—
	4	9	134.1	18.4	9	105.2	14.6
	5	20	132.1	22.6	20	102.3	16.0
	6	3	121.5	19.1	3	95.9	16.3
Cézár	1	5	98.2	15.1	5	76.1	9.9
	2	9	99.6	22.6	9	77.7	17.5

The first generation with 50 per cent Jersey blood.

Since it becomes clear from the data that the growing number of lactations has an effect on these measured properties it is useful to examine whether these differences between lactations are considerable or not. I have completed these examinations among cows of different ages within the progeny groups of the crossed stock.

Table 2

Mean values and standard deviations of the milk protein and casein production of the 50 per cent Jersey cows (F_2) of Városföld per lactation

	Milk protein kg				Casein kg		
Bull	Lactation	n	$\bar{x}$	s	n	$\bar{x}$	s
Dani	56/6 (F_2) 1	3	104.4	20.7	3	80.5	16.2
	2	3	107.6	20.5	3	83.3	6.1
Feri	11/6 (F_2) 3	8	110.3	21.7	8	86.5	16.6
	4	2	136.1	—	2	109.0	—

The second generation with 50 per cent Jersey blood.

Table 3

Examination of the differences between the individual lactations (in kg) per progeny group. Values gained from the variance analysis or t-test Városföld

Bull	Significance value	Milk protein kg	Casein kg
Feri 61 (F_1)	P%	>20	>20
Dani 96 (F_1)	P%	>20	>20
Cézár (F_1)	P%	>90	>80
Dani 56/6 (F_2)	P%	>80	>70
Feri 11/6 (F_2)	P%	>10	>10

For this examination I have used the variance analysis method when dealing with more than two lactations and the t-test when only two lactations were used. With these methods I could discover that the protein and casein content of the milk significantly grew with the advance of lactation. Tables 3 and 6 show the results of the variance analysis and the t-test respectively. From Table 3 it seems that between the individual lactations within the progeny groups there is no significant difference between the F_1 and F_2 cows in protein and casein quantity. The cause of this is — in my opinion — primarily that the F_1 and F_2 cows grouped according to origin have included mostly older ones. The number of F_1 cows in first lactation per bull progeny group has been too few and thus their smaller protein and casein production could only slightly influence the results. Tables 4 and 5 show according to increasing

Table 4

Mean values and standard deviations of the milk protein and casein production during lactation of the progeny groups of the 50 per cent Jersey cows (F_1) of Városföld per lactation

Milk protein %					Casein %		
Bull	Lactation	n	$\bar{x}$	s	n	$\bar{x}$	s
Feri 61	2	4	3.7	0.057	4	2.86	0.037
	3	1	3.16	—	1	2.61	—
	4	1	3.77	—	1	2.98	—
	5	8	3.77	0.133	8	2.96	0.067
	6	4	3.84	0.183	4	2.98	0.212
Dani 96	1	2	3.64	—	2	2.89	—
	2	1	3.65	—	1	2.89	—
	3	2	3.6	—	2	2.98	—
	4	9	3.72	0.162	9	2.92	0.11
	5	20	3.72	0.171	20	2.89	0.15
	6	3	3.56	0.214	3	2.8	0.119
Cézár	1	5	3.62	0.068	5	2.81	0.07
	2	9	3.68	0.197	9	2.87	0.147

Table 5

Mean values and standard deviations of the milk protein and casein percentages of the 50 per cent Jersey cows (F_2) of Városföld per lactation

Milk protein %					Casein %		
Bull	Lactation	n	$\bar{x}$	s	n	$\bar{x}$	s
Dani 56/6 (F_2)	1	3	3.79	0.26	3	2.92	0.101
	2	3	3.75	0.202	3	2.9	0.124
Feri 11/6 (F_2)	3	8	3.75	0.219	8	2.94	0.185
	4	2	3.66	—	2	2.92	—

lactation the mean values and standard deviation of the milk protein and casein percentage of lactation in groups formed according to sires. Table 6 listing together the cows of different lactations in the progeny groups gives the significance for the percentage values of different examined milk components based on variance analysis or the t-test. From the data it appears that there is no significant difference between the mean values of the examined percentage values of the compared cows of different ages within the progeny groups. On the basis of the summarized data of Table 7 comparing the three 50 per cent Jersey blooded progeny groups a smaller protein and casein per-

Table 6

Examination of the differences between individual lactations (in per cent) per progeny group. Values gained from the variance analysis or t-test Városföld

Name of bull	Significance value	Milk protein %	Casein %
Feri 61 (F_1)	P %	>10	>10
Dani 96 (F_1)	P %	>20	>20
Cézár (F_1)	P %	>40	>50
Dani 56/6 (F_2)	P %	>80	>80
Feri 11/6 (F_2)	P %	>60	>80

Table 7

Mean values and standard deviations of the summarized data of the F_1 and F_2 cows Városföld (in per cent)

Jersey F_1	Name of bull	Milk protein %			Casein %		
		n	$\bar{x}$	s	n	$\bar{x}$	s
	Feri 61	18	3.74	0.191	18	2.92	0.129
	Dani 96	37	3.7	0.161	37	2.89	0.136
	Cézár	14	3.6	0.162	14	2.85	0.125
Total Jersey F_1		69	3.7	0.169	69	2.89	0.13
Jersey F_2		16	3.75	0.2	16	2.93	0.153

centage has been noted in the young group of progeny from Cézár. This is — however — a genetical difference because it is not evident between cows with differing lactation numbers within a particular progeny group from the same bull but between these groups.

I have studied the influence of age on the composition of milk protein and casein percentage also in the crossed herds of Pécs and Mezőhegyes. In the Pécs herd mostly the offsprings of two bulls have been included, therefore it was worth treating those even from such a viewpoint. One group has comprised 58 and the other 12 offsprings. Table 8 shows the respective mean values and standard deviations of the offsprings of the two bulls. A quick survey shows that there is no significant difference between the percentage values of the two groups and consequently here I have not studied significance. Such an examination on the protein quantity has produced, however, a significance. Its cause is that the majority of the individuals from the bull with a smaller number of progeny were in the Ist and IInd lactation. Most of the R_1 cows (25 per cent Jersey and 75 per cent Hungarian spotted blood) of the Mező-

Table 8

Results obtained from the progeny of Cinkos and Balázs. Mean values and standard deviations

	Name of bull	Milk protein			Casein		
		n	$\bar{x}$	s	n	$\bar{x}$	s
Kg	Cinkos	12	117.2	23.0	12	89.6	17.7
	Balázs	58	137.8	28.2	58	98.7	21.8
%	Cinkos	12	3.62	0.072	12	2.77	0.086
	Balázs	58	3.65	0.137	58	2.81	0.098

Significance values for kg: $P < 5\%$ $P > 10\%$

Table 9

Mean values and standard deviations of the percentages of milk protein and casein production of the 25 per cent Jersey cows of Mezőhegyes per lactation

Lactation	Milk protein kg			Casein kg		
	n	$\bar{x}$	s	n	$\bar{x}$	s
1	31	91.2	22.7	31	70.7	18.0
2	21	114.9	34.8	21	90.3	27.6
3	8	122.2	18.1	8	94.1	12.7
4	2	166.8	—	2	131.2	—
Total R_1	62	105.69	31.73	62	82.31	25.10
1	31	3.68	0.128	31	2.85	0.107
2	21	3.65	0.187	21	2.87	0.114
3	8	3.59	0.210	8	2.77	0.137
4	2	3.50	—	2	2.76	—
Total R_1	62	3.65	0.162	62	2.84	0.116

hegyes stock were in the Ist and IInd lactation and mainly originated from one bull (Dani 507/5; 56 individuals). I have treated the data of the R_1 group subdivided according to the number of lactations. Table 9 contains the mean values and standard deviations of the R_1 group.

I received a picture similar to the Városföld data when examining the milk protein and casein percentage of lactation of R_1 cows with advancing age. According to Table 9 among the R_1 cows the reduction from the Ist to IVth lactations in protein percentage was from 3.68 to 3.50 per cent while in casein percentage from 2.85 to 2.76 per cent. The differences are not significant.

In general, the results of my examinations agree with the data of literature on the subject although in certain cases this phenomenon, because of the small number of animals involved in lactation, could be observed only as a tendency.

Conclusions

The study of the progeny groups of bulls comprising cows of various ages shows that the protein and casein content of the milk slightly reduces with the advancing age of the cow. According to my examinations this difference is not significant.

The Városföld and Pécs stocks have not disclosed unambiguous differences between the progeny groups of different ages. Among the Mezőhegyes (R_1) cows the reduction from the Ist to IVth lactations (as seen in Table 9) in protein percentage has been from 3.68 to 3.50 per cent, while in casein from 2.85 to 2.76 per cent. These differences are not significant. My observations do not agree with BAILEY's data (1952) which showed a 0.36 per cent reduction in the fat-free dry matter content of the milk of older cows with the advance in the number of lactations. My observations for the most part agree with those of WAITE (1955) who noted a 0.23 per cent reduction and attributed the reduction in the protein content of milk from the Ist to IVth lactations to the increase in milk yield. Finally in agreement with KIERMEIER—PROBST (1962) my experiments show that when comparing the protein and casein content of the milk of offspring groups and stock of different ages, age is a negligible factor. On the other hand the differences in the absolute protein and casein yields of the age groups significantly grow because of the increase in milk yield from the Ist to IVth lactations.

REFERENCES

AURIOL, P.—GROSSCLAUDE, F. (1960): L'évolution avec l'âge, de la composition du lait de vache. Annales de Zootechnique, Paris, **2**, 121—132.

BAILEY, G. (1952): Untersuchungen über Veränderungen im SNF-Gehalt der Milch. Mitt. J. Dairy Res., **19**, 266.

EDWARDS, R. A. (1958): Untersuchungen an 14 Herden, welche Substandmilch im Osten Schottlands erzeugen. J. Dairy Res., **25**, 637.

INICHOW, G. Sz. (1959): Biochemie der Milch und der Milchprodukte. VEB. Verlag Technik, Berlin. 68—71.

KETTING, F. (1957): A tej fehérjetartalmának gyors meghatározása (Quick Determination of the Protein Content of Milk). (Report of the Tejipari Központi Laboratórium) Budapest, Tejipar **1**—**2**.

KIERMEIER, F.—PROBST, A. (1962): Über erbliche Einflüsse auf den Milcheiweissgehalt. Bayer. Landw., München, **5**, 552—560.

POLITIEK, R. D. (1956): Review of the Present Day Problems Posed by Variations in the Solids-non-fat-content of Milk. VII. Congrès international de zootechnique Madrid, Altamira, Theme, **5**, 7—33.

ROKITZKY, P. (1959): Über den Gehalt der Kuhmilch an fettfreier Trockensubstanz. Ref. Landw. Zbl., **3**, 54.

SMITH, V. R. (1962): Solids-non-fat. Department of Dairy Science, University of Arizona. Tuscon, Arizona.

VANSCHOUBROEK, E. J. (1963): Determination and Variation of Protein, Fat and Lactose in Cow's Milk, and Selection on these Factors. Neth. Milk and Dairy J., Wageningen, **1**, 12—45.

VOIGTLÄNDER, K. H. (1964): Der Einfluss des Alters auf die Zusammensetzung der Kuhmilch. Arch. Tierz., **2**, 171—190.

WAITE, R.—WHITE, J.—ROBERTSON, A. (1956): Veränderungen in der chemischen Zusammensetzung der Milch mit teilweisem Hinweis auf den SNF-Gehalt. J. Dairy Res., **23**, 65—81.

WAITE, R. (1955): The Farmer's Weekly. Oct. **105**.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 71—81 (1968)

TECHNIQUES OF MAKING SHORT-TERM TISSUE CULTURES OF POTATO TUBERS

II. EFFECT OF SOME EXOGENOUS AND ENDOGENOUS FACTORS ON THE GROWTH

By

B. FALUDI

DEPARTMENT OF PHYLOGENETICS AND GENETICS, L. EÖTVÖS UNIVERSITY, BUDAPEST

The pH of the environment should be kept close to that of the tissues (in our case pH 6.2). Tissue cultures prepared from potato tubers will grow properly only in the dark. The optimum temperature has been found to be 23 to 26° C. Irradiation of the tubers with γ-rays decreases by 40 to 60 per cent the effect of 2,4-D used in optimum concentration. The inhibitory effect depends more on the time of irradiation than on the increase of the dosage in the range of 10 to 80 kr. Direct irradiation of tissue cultures has revealed that at the time of an intensive stimulation of growth only very high radiation doses are able to inhibit the stimulatory effect of 2,4-D. The optimum weight to start with has been found to be near 25 g. This value was obtained in either of two ways: by increasing the section thickness or the area. Both the section thickness and area have been found to be of significance. The best results are obtained by using a section thickness of 670 μ and an area of 5×5 mm. The use of inappropriate sizes will result not only in a decrease of the growth index and in unfavourable percentages of variation but also in the occurrence of demarcation phenomena near the optimum size. Tissue growth is influenced also by the date of storage to different extents depending on whether 2,4-D was applied in suboptimum, optimum or growth inhibiting concentrations. When the optimum concentration of 2,4-D is used the ease with wich stimulation can be effected is least at the beginning and at the end of the storage period.

Introduction

In non-differentiated tissues most part of the genetic machinery is inactive and is present only as a potential reserve. This is the reason for the fact that the environmental requirement of such tissues is in many respects different from that of whole plants. The conditions may vary only in a narrow range because the tolerance of excised tissues is more limited (WENT 1954) and even within the limits of tolerance some more genes may become activated or differentiated (BONNER 1965). In our experiments, in addition to the pH, and different radiation effects (light, temperature, ionizing radiation) some factors due to the vicinity of other cells (STEWARD 1963) have also been taken into consideration. These latter were partly a function of the starting size. Finally the possibility of the existence of a yearly rhythm reflecting variations in endogenous and exogenous factors has also been investigated.

Material and Methods

In the experiments tuber tissues of *Solanum tuberosum* have been used. The methods applied were described in an earlier publication (FALUDI 1966).

Experimental Results

Choosing the right pH. For a proper growth of tissue explants a pH of 5.5 to 6.5 has been reported in the literature (HENDERSON 1954, JAGENDORF *et al.* 1952, STEWARD—CAPLIN 1951). The pH of potato tuber tissues is known to vary in an exceptionally narrow range, between pH 5.8 and pH 6.5 (PROKOSEV 1947). By ensuring a pH of 6.2 in our cultures good results have been obtained.

Effect of light, temperature and ionizing radiation. The determination of the optimal combined effect of light and temperature (BÜNNING—WELTE 1954, DE CAPITE 1955) is generally necessary to maintain the conditions of the endogenous rhythm (ENDERLE 1951). In this respect, however, our experimental object has a peculiar feature. Cultures of both potato tubers (FALUDI 1957) and potato stems were shown by most, if not all, authors to grow intensively only in the dark. Under such circumstances only the determination of the optimum temperature seemed to be necessary. It has recently been observed that in some species the temperature optimum extremely differs from the temperature requirement of the whole plant (GAUTHERET 1961*a*, *b*). In our experiments three temperature values have been examined (Table 1).

Table 1

Determination of the optimum temperature for tissue cultivation

Temperature, °C	Tissue weight on the 14th day, mg $\pm s_{\bar{x}}$	V%	Absolute increase in weight, mg	G. I.
15 ± 2	36 ± 0.6	1.7	11	1.4
25 ± 2	127 ± 2.7	2.1	102	5.1
35 ± 2	84 ± 3.5	4.2	59	3.4
Starting weight, mg	25 ± 0.1	0.4		

Table 1 shows that potato tubers grow excellently at 23 to 26° C and that temperatures higher than that are better tolerated by the tubers than temperatures below 23° C.

The effect of γ-radiation was investigated four times during storage: in November, December, February and March (FALUDI—PARÁDI 1964). The radiation dose was varied from 10 to 80 kr. The efficiency of the irradiation was checked by the use of barley seeds inserted into the potato tubers (EHRENBERG 1955, CALDECOTT 1955). The results are shown in Table 2.

Table 2

Growth of tissue cultures from γ-irradiated potato tubers on a nutrient medium containing 10^{-4} M 2,4-D

Date of irradiation	Control	10 kr	20 kr	30 kr	40 kr	80 kr
	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$
November	79 ± 0.91	79 ± 1.43	69 ± 0.89	71 ± 1.25	68 ± 1.10	48 ± 1.66
December	109 ± 1.40	98 ± 1.11	70 ± 0.89	72 ± 1.00	56 ± 0.58	43 ± 0.50
February	125 ± 1.90	106 ± 2.00	89 ± 1.21	73 ± 0.92	86 ± 0.80	69 ± 0.67
March	144 ± 1.00	107 ± 1.41	105 ± 1.50	96 ± 1.00	90 ± 0.91	80 ± 0.67

From the data in Table 2 the following conclusions can be drawn:

a) The inhibitory effect of γ-radiation on growth depends much more on the date of irradiation than on the dosage. The minimum dosage that had to be used to get a pronounced inhibition of growth was 80 kr in November, 40 kr in December and 10 and 20 kr in February and March, respectively.

b) The rate of inhibition and the ease with which growth can be stimulated are more or less proportionate.

c) Irradiation of the tubers results in a 40 to 60 per cent reduction of the stimulatory effect of 2,4-D but does not lead to a complete suppression of growth.

The antagonism between growth stimulation, as well as ionizing radiation has been studied also by the direct irradiation of the explants (Table 3).

Table 3

Effect of γ-irradiation on the growth of potato tissues irradiated in the nutrient medium containing 10^{-4} M 2,4-D

Date of irradiation	Control	10 kr	20 kr	30 kr	40 kr	80 kr
	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$	mg $\pm s_{\bar{x}}$
2-day-old tissues	101 ± 1.25	53 ± 1.20	60 ± 2.00	55 ± 1.54	63 ± 1.32	47 ± 1.02
5-day-old tissues	111 ± 1.80	111 ± 2.75	110 ± 2.88	103 ± 2.02	102 ± 1.67	98 ± 1.75

It may be seen that at the time when intensive growth started (on the 5^{th} day) the irradiation of the tubers with γ-rays had a less pronounced effect and neutralized the growth stimulating effect of 2,4-D only in the case of high doses.

The significance of the optimal starting size. The significance of the optimal starting size has been emphasized by several authors. However, only a limited number of papers deal with its experimental determination and even if they do so the results presented are fragmentary (NOBÉCOURT 1938, HELLER 1953, STEWARD—CAPLIN 1954, FALUDI *et al.* 1962).

We have examined what the optimal starting weight of our experimental object is and whether the way in which this is achieved is of any importance. In our earlier experiments (FALUDI 1957) optimal starting weight was found to be 25 to 30 mg. The question arises whether the thickness or the area of the tissue section is a more important factor in obtaining the right size. This may be significant from the point of view of both the dependence on the nutrient medium and the interdependence of the cells.

First an area of 5×5 mm was kept constant and the thickness of the sections was changed by adjusting the microtome to the positions desired. The results are shown in Table 4.

Table 4

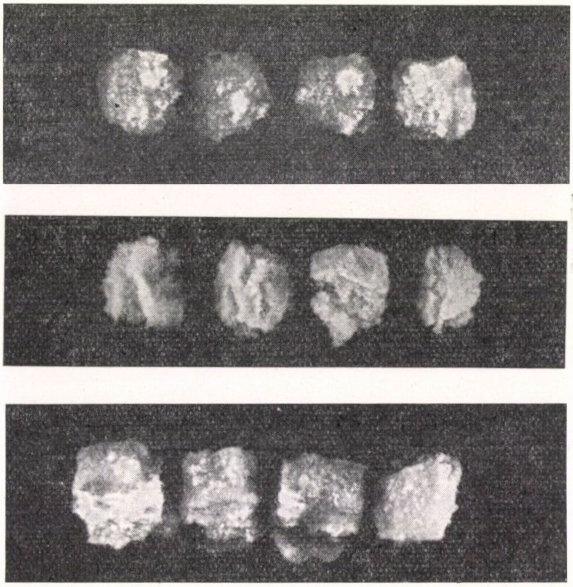
Relationship between the thickness of sections and the optimal starting weight

Thickness, μ	Starting weight, mg $\pm s_{\bar{x}}$	Tissue weight on the 14th day, mg $\pm s_{\bar{x}}$	V %	Absolute increase in weight, mg	G. I.
320	14 ± 0.16	13 ± 0.01	0.1	-1	-0.1
670	25 ± 0.11	129 ± 2.22	1.7	104	5.1
1330	51 ± 0.16	164 ± 1.41	0.9	113	3.2
2020	85 ± 0.37	205 ± 2.30	1.1	120	2.4
4100	177 ± 0.20	294 ± 2.90	1.0	117	1.6

It is clear from Table 4 that a section thickness of 320 μ does not permit any weight increase, despite the fact that by taking an average cell size of 70 to 100 μ there should be enough intact cells left. With a section thickness of 670 μ the absolute increase of weight is significant and the growth index [G. I. = final weight (mg) per starting weight (mg)] is very high (5.1) indicating an intensive rate of growth. On the other hand, further increase in the section thickness does not lead to an enhanced rate of weight increase. This is shown by the rapid decrease of the growth index. The decrease of the percentage of variation (variation coefficient) points — under optimal standard conditions — to the fact that the decrease of the rate of growth is due to an unfavourable section thickness.

The suggestion, that even with sections thicker than the optimum, growth is mainly ensured by the tissue structure of the optimal section, is supported by the fact that a demarcation and almost a complete detachement of thicker tissues takes place approximately at this very borderline (Fig. 1).

Next, the optimum starting weight was approached by changing the area of the sections, while a section thickness of 670 μ was kept constant (Fig. 2).



a

b

c

Fig. 1. Correlation between thickness of the sections and optimal starting weight. $a = 670\ \mu$ and 5.1 G. I., $b = 1330\ \mu$ and 3.2 G. I., $c = 4100\ \mu$ and 1.6 G. I.

Choosing the right area seems to be as important as selecting the right section thickness. If the results are compared with the data in Table 4, where the optimum area was 5×5 mm in contrast to the value of 6×6 mm (absolute weight increase, 104 and 110, respectively; G.I. 5.1 and 5.2, respectively) it seems as if the area could be varied within broader limits than section thickness. However, the fact that with an area of 6×6 mm the percentage of variation is more than twice as high (3.9 per cent) as in the other case shows that making use of this possibility is not advisable. The cause of this difference is most probably due to a difference in the interface between the tissue and the nutrient medium rather than to an interaction between cells.

Seasonal rhythm. As pointed out by literary data the ease with which tissues excised from storage organs can be stimulated by natural auxin depends very much on the time of the year (GAUTHERET 1939).

It has been reported that tissues of some species are able to grow in certain months of the year without any external supply of auxin (KULESCHA 1954). Therefore the determination of the seasonal rhythm of individual test species seems to be an indispensable prerequisite for reliable cultivation. The question is to what extent endogenous rhythm becomes manifest when tissues are exposed to 2,4-D. To answer this question tissue cultures were prepared in each month during two consecutive years with nutrient media containing 2,4-D in a concentration of 0, 10^{-7}, 10^{-5}, 10^{-4} and 10^{-3} M, respectively. With nutrient media containing 10^{-7} M 2,4-D or none the weight of tissues increased

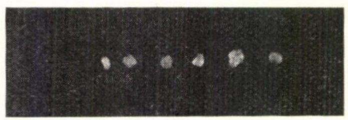
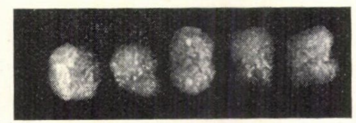
Age of the culture	1×1 mm	2×2 mm	6×6 mm
	mg ± $s_{\bar{x}}$	mg ± $s_{\bar{x}}$	mg ± $s_{\bar{x}}$
Day of start	1.2 ± 0.05	4.1 ± 0.10	26.0 ± 0.29
14 days after the start	 3.0 ± 0.21	 9.3 ± 0.37	 136.0 ± 4.80
Absolute increase in mg	1.8 ± 0.20	5.2 ± 0.39	110.0 ± 4.30
G. I.	2.5	2.3	5.2

Fig. 2. Correlation between area and optimal starting weight

from 25 mg to 33—37 mg at the most. Thus, potato does not belong to those species which are able to grow in certain months of the year without any external supply of growth hormones. Table 5 shows only the data of stimulated and inhibited growth (2,4-D in a concentration of 10^{-5} M, 10^{-4} M and 10^{-3} M, respectively).

Table 5

Monthly fluctuations in weight increase during storage

Month	Weight increase, mg $\pm s_{\bar{x}}$		
	10^{-5} M 2,4-D	10^{-4} M 2,4-D	10^{-3} M 2,4-D
August	40 ± 0.74	120 ± 5.80	27 ± 0.64
September	55 ± 1.06	92 ± 1.23	26 ± 0.28
October	39 ± 0.72	95 ± 1.11	26 ± 0.28
November	38 ± 0.82	121 ± 4.80	30 ± 0.70
December	60 ± 1.34	118 ± 1.94	30 ± 0.38
January	57 ± 1.28	134 ± 2.24	26 ± 0.43
February	51 ± 1.50	149 ± 4.53	29 ± 0.33
March	52 ± 1.40	111 ± 1.89	36 ± 1.40
April	48 ± 1.08	132 ± 4.65	36 ± 0.54
May	87 ± 3.04	154 ± 4.39	32 ± 0.80
June	41 ± 0.78	100 ± 3.21	75 ± 1.94
July	58 ± 1.64	98 ± 5.22	54 ± 2.30

From Table 5 the following conclusions may be drawn:

1. Each concentration used has a different effect with respect to the ease with which stimulation can be achieved.

2. These differences are not parallel in suboptimal, optimal and growth inhibiting concentrations.

3. The suboptimal concentration of 2,4-D has a relative stimulatory effect in September, December, May and July.

4. The optimum concentration of 2,4-D ensures a minimum stimulation of growth at the beginning and at the end of the storage period whereas it gives a maximum stimulation of growth in the period from November to May.

5. The growth inhibiting effect of 2,4-D is equally well pronounced in the period from August to May whereas in June and July it is nearly suboptimal. This shows that seasonal variations are only partly, if at all, due to differences in sensitivity. The most probable explanation for seasonal variations lies in metabolic differences of the tissues.

Discussion and Conclusions

Non-differentiated tissue cultures will be satisfactory and well reproducible representatives of the whole organism only if in addition to the optimal heterotrophic requirements some other special exogenous and endogenous requirements of the tissues are also fulfilled. Previous experiments have shown these requirements to be not only species specific but also variety specific (FALUDI *et al.* 1964).

It has been found that the pH of the environment should be kept close to that of the tissues. Illumination can be very different from that required by the intact plant. In addition to potato there is only a single other species *(Ipomea pandurata)* which can be grown in the dark (LINGAPPA 1957). With other species, requirement for light is a function of temperature requirement.

Our experiments on temperature requirement have shown that from the point of view of temperature optimum tissue cultures of *Solanum tuberosum* belong to the type of *Zea mays* (26° C) (STRAUS—LARUE 1954) and that with respect to temperature tolerance it is closer to the extremely temperature requiring *Helianthus tuberosus* (31 to 33° C) than to the representative of the opposite extreme situation, *Endivia*, which has an optimum of 6° C and is hardly able to grow at 16° C (GAUTHERET 1961*a*, *b*).

Some authors have reported the existence of cross resistance to ionizing radiation and other agents. Such a cross resistance appears upon infection (RAKITIN—KRYLOV 1957, RUBIN *et al.* 1959) and upon recovery after injury (ENGEL 1952). Our results point to a more intricate correlation and suggest the existence of antagonism rather than cross resistance. Resistance to γ-radiation depends more on the time of storage than on the dosage applied. The data obtained from the analysis of tissues that had been subjected to direct irradiation suggest that γ-radiation affects induced tumorous growth.

In the past the significance of the starting weight was studied with different aims and with various methods of evaluation and therefore the results obtained are difficult to compare. Earlier authors (VÖCHTING 1878, RECHINGER 1893) were looking for the smallest size which still exhibited polarity from the point of view of the relation of the whole to the part. Later on, the maintenance of the ability of regeneration was being studied (FUCSKO 1912). In these investigations it was not considered significant to start with non-differentiated tissues as according to later authors (ROBBINS 1922, KOTTE 1922) it was. Even today some authors start with such extreme values that are hardly justified if at all by species differences. With the same species, e.g. *Daucus carota* sometimes extremely different weights such as 250 mg (NOBECOURT 1938), 100 mg (HELLER 1953) or 4 mg (STEWARD—CAPLIN 1954) were used. At other times species differences are disregarded and the results are compared by analyzing samples of identical weight, e.g. 30 mg (DUHAMET 1951).

With respect to the values obtained in our experiments values of 50 mg established for *Helianthus annuus* (HENDERSON 1954) and of 15 mg established for *Helianthus tuberosus* (NITSCH—NITSCH 1956) are most suggestive because both the above species have cultural requirements that are relatively close to those of potato. Our data fall in between the two above values.

Only a few authors have published data which would suggest that the values are optimal for the experimental object used (HELLER 1953, GAUTHERET 1959, FALUDI *et al.* 1962).

The data obtained in our experiments are most similar to those obtained by HELLER (1953) who studied the correlation between the starting weight and the percentage of variation in cultures of *Parthenocissus tricuspidata*. Although HELLER has found a tendency similar to ours, his method of evaluation is, however, problematic from several points of view. HELLER started off with a section thickness of 1330 μ and took into consideration only weights ranging from 55 mg to 219 mg. However, his results are calculated on the basis of absolute weight increase, we have come to the conclusion that calculating on the basis of G. I. even the smallest size chosen by him is far from being optimal and the further tendency points downward. Therefore the decrease of the percentage of variation considered by him as an improvement of the conditions is, in fact, an indication of a decreasing tendency of growth, since the identity of the starting values, together with a reduced rate of growth, has a greater effect on the variation coefficient. A further weakness of HELLER's method of evaluation consists in his having disregarded the area.

On the other hand, the point could be set against our experiments that changes in conditions of nutrient uptake and translocation have not been separately taken into account. There is, however, one finding which suggests that these processes may not be of a great importance. It has been found that during the period of their most intensive growth the tissues considerably surpass the zone of optimum size and thus the above processes will play a gradually increasing role only after the 11th day.

REFERENCES

BONNER, J. (1965): The Molecular Biology of Development. Oxford, Clarendon Press.

BÜNNING, E.—WELTE, H. (1954): Photoperiodische Reaktionen in pflanzlichen Gewebekulturen. Physiol. Plant., **7**, 197—203.

CALDECOTT, R. S. (1955): Ionizing Radiation as a Tool for Plant Breeders. Proc. Int. Conf. Peaceful Uses Atomic Energy, **12**, 40—45.

DE CAPITE, L. (1955): Action of Light and Temperature on Growth of Plant Tissue Cultures in Vitro. Amer. J. Bot., **42**, 869—873.

DUHAMET, L. (1951): Action du lait de coco sur la croissance des cultures de tissus de crowngall, de vigne, de tabac, de topinambour et de scorsonère. C. R. Soc. Biol., **145**, 1781—1783.

EHRENBERG, L. (1955): The Radiation-induced Growth Inhibition in Seedlings. Bot. Notiser, **108**, 184—215.

ENDERLE, W. (1951): Tagesperiodische Wachstums-, und Turgorschwankungen an Gewebekulturen. Planta, **39**, 570—588.

ENGEL, O. S. (Энгель, О. С.) (1952): Чувствительность ткани клубней картофеля к рентгеновским лучам в зависимости от физиологического состояния клубней. Докл. АН СССР, **85**, 437—439.

FALUDI, B. (1957): Data on the Physiology of Growing Potato Tissue in Vitro. Ann. Univ. Sci., Bp. **1**, 55—60.

FALUDI, B. (1966): Techniques of Making Short-term Tissue Cultures of Potato Tubers. I. Effects of the Composition on the Growth Medium. Acta Agronom. Acad. Sci. Hung., **15**, 1—12.

FALUDI, B.—PARÁDI, E. (1964): A γ sugárzás hatása a 2,4-D-vel indukált növekedésre (Effect of γ-radiation on the Growth in Media Containing 2,4-D). III. Biofizikai Vándorgyűlés, Budapest.

FALUDI, B.—FALUDI-DÁNIEL, A.—PACSÉRY, M. (1962): A 2,4-D szenzitív burgonyafajta szövettenyészetének növekedése és az indulási méret közötti összefüggés (The Growth of the Tissue Culture of the 2,4-D-sensitive Potato Variety as Related to its Initial Size). Biol. Közl., **10**, 17—21.

FALUDI, B.—FALUDI-DÁNIEL, A.—GYURJÁN, I.—PACSÉRY, M.—ANDA, S. (1964): Fajtakülönbségek különböző auxinok növényi szövettenyészet növekedését serkentő hatásában (Varietal Differences in the Growth Response of Tissue Cultures Induced by Different Auxins). Biol. Közl., **12**, 17—24.

FUCSKO, M. (1912): A burgonya hipertrófiás szövetei (Hypertrophic Tissues of Potato). Bot. Közl., **11**, 14—29.

GAUTHERET, R. J. (1939): Sur le développement des fragments de tubercules de chou-rave. C. R. Soc. Biol., **130**, 244—247.

GAUTHERET, R. J. (1959): La culture des tissus végétaux. Paris. 863.

GAUTHERET, R. J. (1961*a*): Action de la température et la lumière sur le développement des tissus cultivés in vitro particulièrement des fragments de rhizomes de topinambour. 86-ième Congr. Soc. Sav., 509—525.

GAUTHERET, R. J. (1961*b*): Action de la température et de la lumière sur l'accroissement des tissus de topinambour cultivés in vitro. Compt. R. Séance Soc. Biol., **155**, 693—698.

HELLER, R. (1953): Recherches sur la nutrition minérale des tissus végétaux cultivés in vitro. Doct. Thèses. Paris, pp. 223.

HENDERSON, J. H. M. (1954): The Changing Nutritional Pattern from Normal to Habituated Sunflower Callus Tissue in Vitro. Ann. Biol., **30**, 329—348.

JAGENDORF, A. I.—BONNER, D. M.—NAXLOR, A. W. (1952): An Atypical Growth of Cabbage Seedling Roots. I. Morphology, Histology and Induction Conditions. Bot. Gaz., **113**, 334—347.

KOTTE, W. (1922): Kulturversuche mit isolierten Wurzelspitzen. Beitr. Allg. Bot., **2**, 413—434.

KULESCHA, Z. (1954): Croissance et teneur en auxine de divers tissus normaux et tumoraux. Ann. Biol., **30**, 319—327.

LINGAPPA, Y. (1957): Tissue Cultures of *Solanum tuberosum* and *Ipomea pandurata*. Amer. J. Bot., **44**, 419—423.

NITSCH, J. P.—NITSCH, C. (1956): Auxin-dependent Growth of Excised *Helianthus tuberosus* Tissues I. Amer. J. Bot., **43**, 839—851.

NOBÉCOURT, P. (1938): Sur les proliférations spontanées des fragments de tubercules de carotte et leur culture sur milieu synthétique. Bull. Soc. Bot. France, **85**, 182—188.

PROKOSEV, S. M. (Прокошев, С. М.) (1947): Биохимия картофеля. Москва.

RAKITIN, J. V.—KRILOV, A. V. (Ракитин, Ю. В.—Крылов, А. В.) (1957): Физиологические изменения у растений при задержке их роста гамма-лучами. Физиол. Раст. **4**, 82—85.

RECHINGER, C. (1893): Untersuchungen über die Grenzen der Teilbarkeit im Pflanzenreich. Verhandl. Zool. Bot. Ges., Wien, **43**, 310—334.

ROBBINS, W. J. (1922): Cultivation of Excised Root Tip and Stem Tips under Sterile Conditions. Bot. Gaz., **73**, 376—390.

RUBIN, B. A.—METLICKY, L. V.—SALKOVA, E. G.—MUHIN, E. N.—KORABLEVA, N. P.—MOROZOVA, N. P. (Рубин, Б. А.—Метлицкий, Л. В.—Салькова, Э. Г.—Мухин, Э. Н.—Кораблева, Н. П.—Морозова, Н. П.) (1959): Использование ионизирующих излучений для управления покоем клубней картофеля при хранении. Москва. Биохим. плодов и овощ. **5**, 5—101.

STEWARD, F. C. (1963): The Control of Growth in Plant Cells. Sci. American, **209**, 104—113.

STEWARD, F. C.—CAPLIN, S. M. (1951): A Tissue Culture from Potato Tuber. The Synergetic Action of 2,4-D and of Coconut Milk. Science, **113**, 518—520.

Steward, F. C.—Caplin, S. M. (1954): The Growth of Carrot Tissue Explants and its Relation to the Growth Factors Present in Coconut Milk. I/A. The Development of the Quantitative Method and Factors Affecting the Growth of Carrot Tissue Explants. Ann. Biol., **30**, 385—394.

Straus, J.—La Rue, C. D. (1954): Maize Endosperm Tissue Grown in Vitro. I. Culture Requirements. Amer. J. Bot., **41**, 687—694.

Vöchting, H. (1878): Über Organbildung im Pflanzenreich. I—II. Bonn.

Went, F. W. (1954): Physical Factors Affecting Growth in Plants. In: Dynamics of Growth Processes. (Ed.: Boell, E. J.) 130—147.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 83—99 (1968)

ANALYSIS OF THE PHOTOPERIODICAL RESPONSE OF POPPY

I. EXPERIMENTAL DISTINCTION OF THE TYPES OF PHOTOPERIODICAL RESPONSE

By

A. ANDRÁSFALVY

RESEARCH INSTITUTE OF HORTICULTURE, BUDAPEST — BUDATÉTÉNY

In a collection of fifty cultivated poppy varieties a remarkably early flowering variety in experiments of periodical seeding technique and subsequently with photoperiodical treatment proved to be indifferent to daylength. The vegetation period of the other varieties of the assortment was very different according to the geographical origin of the varieties, but all of them were of quantitative long-day type. In spring sowing the flowering date depended on the critical inductive photoperiodical requirement of each variety. Length of the critical photoperiod and number of cycles necessary for induction have changed also to some extent with the age of plant and with temperature. Photoperiodical response of varieties adapted to autumn seeding has been more explicit than that of varieties grown as a rule by spring seeding. In the case of the formers the more intense photoperiodical response of younger plants has not been altered to such an extent with aging of the plant as in the spring type.

Introduction

VESSELOVSKAYA (1933) has been the first to investigate the relationship between different daylength requirement and geographical origin of poppy varieties. Similar phenomena were established for other cultivated plants e.g. for summer wheat (DOROSHENKO 1927), onion, radish and spinach (BREMER—WEISETH 1961) etc.

REATH—WITTWER (1952) described a case of definite day neutrality in peas, having observed that at lower temperatures neutrality changed to long-day response. The mechanism of this phenomenon in peas was differently explained by BARBER (1959) and HAUPT (1957, 1958). In the case of lettuce BREMER (1962) supplied a definition of day neutral response contrary to the former in many respects. Day neutrality of some varieties of long- and short-day species was attributed by KOPETZ (1956) to their extreme photoperiodical thresholds.

MIKA (1955) examined experimentally the modifying effect of temperature on the photoperiodical response of poppy. Also indications on the vernalization requirement of poppy are available (LECAT 1955). Possibilities in Hungary of autumn seeding usual in poppy growing in the Balkans and Asia Minor were dealt with by SÁRKÁNY—ANDRÁSFALVY—F. RIEDEL (1959) and by UNK (1961). The impact of vernalization and photoperiodic response to frost resistance of plants sown in the autumn was examined by TALALAYEV (1936) and RUDORF (1938).

A case of different sensitivity to the effect of photoperiodism and temperature was described by Gries—Stearns—Caldwell (1956) and Riddell—Gries (1958) in the case of summer wheat varieties.

We reported on the ontogenetical data of part of the poppy varieties involved also in the present paper and on results of our experiments of periodical seeding technique (sowing time variations) in an earlier paper (Sárkány—Andrásfalvy—F. Riedel 1959). The ecological type of the variety *Madurovics*, of the Hungarian improved varieties and of the opium varieties of East Mediterranean origin were observed for the first time in earlier experiments of periodical seeding technique. The main reason of differences in developmental rhythm and winter hardiness was sought in the different photoperiodical response. In the present study the relationship between the ecological type of the varieties and the effect of artificial photoperiods on the beginning of the reproductive phase has been considered.

Material and Methods

In the winter season 1957/58 a photoperiodical experiment was established with six and in 1958/59 with further two varieties. Short characterization of the varieties is presented in Table 1.

Except for the accession "*Indiai*" the seeds of mother plants inbred for several years and forced to self pollination by isolation with pergamin bags were sown at December 3, 1957 in clay pots of 10 cm diameter. In 1958/59 several sowings were carried out, e.g. on November 27 and December 10, 1958, in order to be able to observe the response of plants of various age. For the experimental approach of the critical light intensity in maximally inductive (24 hour) photoperiods a further seeding of the variety "*Hatvani*" was made at January 17. Plants of various age were kept for a definite number of natural photoperiods supplemented by artificial illumination, while control plants developed on natural daylength only. The astronomical daylength varied in the period between November 26 and May 2 in Budapest between 8^h 26′ and 14^h 50′. During this period light intensity developed according to the season and highly changed depending on cloudiness. The experimental plants in the section of the day between sunrise and sunset obtained a photoperiod supplemented to 24, 15 or 14 hours and were protected with portable vertical shades of black paper from the effect of direct light arriving from the neighbouring treatments. To determine the number of the necessary inductive photoperiods plants of various ages were placed for various periods under long-day conditions.

Artificial light was supplied by Tungsram incandescent lamps of 100 watt power. At the level of plants an average illumination of 600 lux was measured which proved to be more than sufficient to induce photoperiodical response. The incandescent lamps arranged at a height of 30 to 40 cm above the plants irradiated not only heat which directly warmed up the surface of leaves but also induced increased photosynthesis. As a result the plants kept on the 24-hour photoperiod developed more vigorously which manifested itself both in dimensions and number of leaves. There was no direct possibility to separate — by experiment — the effects of photoperiodical induction, photosynthesis and heat irradiation.

In the first weeks of experiment the mean temperature of the greenhouse can be characterized by means of thermographic data as follows:

		1957/58	1958/59
December	1—7	13 °C	13 °C
	8—14	14 °C	15 °C
	15—21	11 °C	16 °C
	22—28	11 °C	17 °C
	29—I. 4	6 °C	12 °C

		1957/58	1958/59
January	5–11	8 °C	13 °C
	12–18	10 °C	
	19–25	12 °C	

On the temperature of the period after January 25, 1958, no exact data are available, as the plants had to be transferred then in another greenhouse where the average temperature was higher, the daily fluctuation of heat somewhat wider.

In 1958/59 the conditions of the experiment similar to the former one differed mainly in that temperature was higher. Here data were available until January 11. Subsequently temperature was rising still higher and thus the experiment had to be closed on April 6.

During the experiment samples were taken several times from the plants developing till then in a pot and the vegetation point was examined with stereomicroscope; at the same time all foliar leaves from the cotyledon level to the smallest leaf protuberance seen on the growing point were counted. On basis of the changes appeared on the growing point the beginning of the reproductive phase, that is of the differentiation of the bud on the main axis, was recorded (SÁRKÁNY—PERCS 1957). For each lot the average of samples taken on one occasion are represented in the Tables. Having determined the developmental state of the growing point conclusions were drawn by extrapolation on the beginning of the reproductive phase i.e. the appearance of the calyx primordia. Part of the plants that remained after repeated sampling were raised until flowering and still further. Thus we had an opportunity to check homogeneity of induction and possibly to observe anomalies that arose as a result of incomplete induction.

Experimental Results

Date of the beginning of the differentiation of flowers depending on illumination. The results of observations made in the 1957/58 experiments at various dates concerning condition of the growing point are presented in Table 2. Results of the 1958/59 experiment were elaborated similarly but are not represented here with the same details. The generative growing point appeared in most cases uniformly and unequivocally in the lot of a variety kept on a definite photoperiod. The deviations were due partly to the different developmental state of plants and partly of non-measurable environmental effects which asserted themselves better in less inductive photoperiods around the critical threshold value. In this respect e.g. the response of the variety *Pitvarosi* deserves attention in the treatment of 15-hour illumination. Appreciable genetical differences in the repeatedly inbred varieties have not been expected to occur.

Threshold value of the length of photoperiod. The differences arising among varieties supplied characteristic relative values. It is evident that the 15-hour illumination was already a daylength considered to be inductive, but the intensity of induction lagged considerably behind that of the 24-hour illumination. The crucial daylength must be shorter. In case of certain varieties, however, the 14-hour photoperiod might be very near to the data of the 1958/59 experiment, but in the 1956/57 experiment of periodical seeding technique flower primordia appeared on the overwintered plants of the variety *Hódmezővásárhelyi* on about April 18 (at photoperiods of about $13^h 45'$).

Natural daylength in the check at the beginning of reproductive phase was — on the other hand — surprisingly short in case of other varieties, as indicated by Table 3 and Figs 1 and 2.

Table 1

Short characterization of the experimental varieties

Mark	Name	Origin	Rosette leaf	Colour of flower	Colour of seed	Earliness	Note
	of the variety						
M	*Madurovics*	from collection	lobate	white with violet spot	light grey	very early	
H	*Hatvani*	improved	lobate	white with violet spot	blue	medium	widespread variety
S	*SC*	improved	lobate	white with violet spot	light grey	late	of high alkaloid content
Ho	*Hódmezővásárhelyi*	Hungarian local variety	strongly lobate, glaucous	dark violet	mixed blue	early	suited for autumn sowing
O	*Opiiferum*	East-Mediterranean	strongly lobate, glaucous	pure white	straw	early	
P	*Pitvarosi*	Hungarian local variety	lobate, spotted	rosa with pale violet spot	dirty earth coloured	late	vigorous with large capsules
Bü	*Büdszentmihályi*	East-Mediterranean	strongly lobate, glaucous	dark violet	mixed greyish black	very early	small size
I	*Indiai*	Indian lot	lobate	pure white	straw	very early	small size

Table 2

Results of examinations concerning the date of the appearance of the growing point 1957/58
(v = number of vegetative, g = number of generative plants)

Natural examination

Date of examination month, day	M v	M g	H v	H g	S v	S g	Ho v	Ho g	O v	O g	P v	P g
I. 4.	6		3		2		3		3		2	
8.												
10.												
14.		5	2		2		4		4		2	
16.			1		1							
20.			5		4		6		4		4	
23.			7		2		7				4	
28.												
31.												
II. 3.												
7.			4				4					
13.			4				5					
22.							4					
III. 5.			6		4		5		4		3	
18.			2	11	6		5		4		6	
26.				5	5		6		5		7	
30.				10		3	10		10		5	
IV. 5.						5	2	1	4		5	1
10.							4		3		2	
14.							4	3	2		2	
18.								6	5		1	2
23.								3	1	1	1	3
28.								2				3

15-hour illumination

Date of examination month, day	M v	M g	H v	H g	S v	S g	Ho v	Ho g	O v	O g	P v	P g
I. 4.	5	4	6		3		10		6		3	
8.	1	2	5		4		6		3		2	
10.		7					8		6			
14.			6		5		6		6		2	
16.			6		6		7		5		2	
20.			6		5		2	8	4	3	6	
23.			3	8	8			12	4	5	10	
28.				8	1	8		5		6		3
31.						5				4	2	2
II. 3.											1	2
7.											1	1
13.											1	1
22.											3	
III. 5.											3	
18.											3	1
26.												
30.												
IV. 5.												
10.												
14.												
18.												
23.												
28.												

24-hour illumination

Date of examination month, day	M v	M g	H v	H g	S v	S g	Ho v	Ho g	O v	O g	P v	P g
I. 4.		13	6		5		2	14		10	4	
8.	2	4		9	3	6		6		5	4	
10.											1	4
14.		2		4		5		4		6		3
16. – IV. 28.												

M = *Madurovics*, S = *SC*, H = *Hatvani*, Ho = *Hódmezővásárhelyi*, O = *Opiiferum*, P = *Pitvarosi*

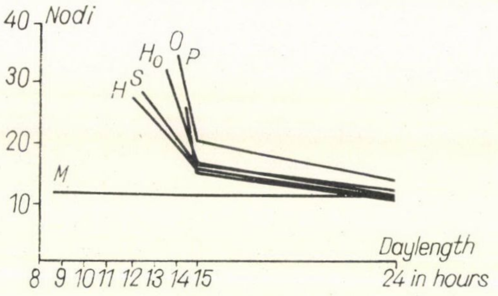


Fig. 1. The number of vegetative internodes of six poppy varieties raised on natural days and from the 8th day after emergence on photoperiods supplemented to 24 and 15 hours

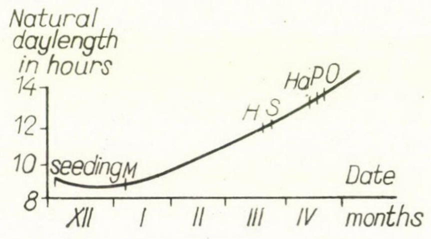


Fig. 2. The effect of natural, steadily elongating days on the formation of the reproductive growing point of six poppy varieties. Emergence: December 6

Table 3

Crucial photoperiod of different varieties developing on natural, steadily elongating photoperiods and age of plants at the beginning of the reproductive phase

Variety	Daylength (hour)		Age of plants from emergence (days)		Date	
	1958	1959	1958	1959	1958	1959
Madurovics	8.8	abt. 9.5	34	abt. 58	Jan. 14	abt. Jan. 30
Hatvani	12.0	—	97	—	March 18	—
SC	12.7	abt. 12.8	108	abt. 117	March 29	abt. March 30
Hódmezővásárhelyi	13.5	>13.1	124	>124	Apr. 14	> Apr. 6
Opiiferum	14.0	>13.1	133	>124	Apr. 23	> Apr. 6
Pitvarosi	13.7	>13.1	128	>124	—	> Apr. 6
Büdszentmihályi	—	>13.1	—	>124	—	> Apr. 6
Indiai	—	abt. 12.8	—	abt. 110	—	abt. March 30

The minimum number of inductive cycles. Results of photoperiodical treatments applied at various ages are presented in Tables 4a and b.

The experimental data enabled us to examine the interaction of the age of plant and the minimum number of inductive cycles necessary. Older and

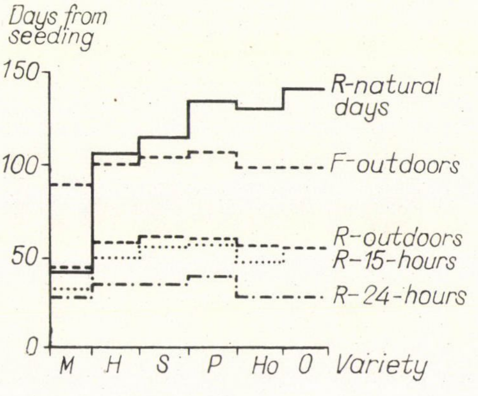


Fig. 3. The length of the vegetative phenophase of six poppy varieties on various artificially supplemented photoperiods and in outdoor seeding. R = onset of flower differentiation, F = beginning of flowering in outdoor spring sowing

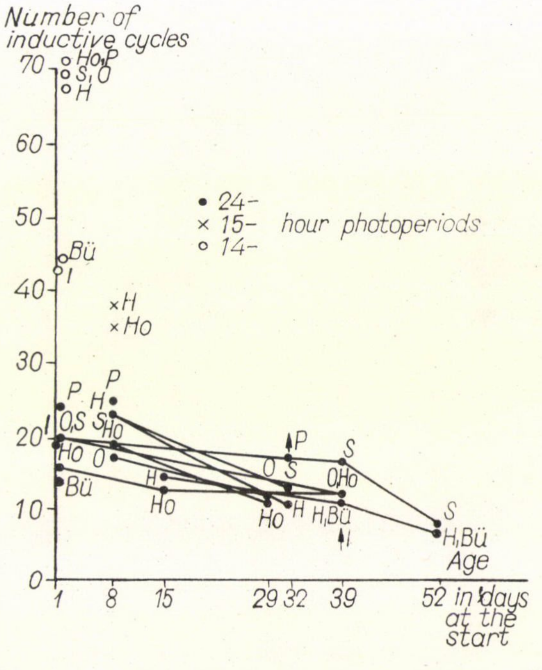


Fig. 4. Relationship between number of inductive photoperiodical cycles necessary for the appearance of flower primordia of various poppy varieties and age expressed in days at the beginning of induction. Signs of the varieties: Bü = *Büdszentmihályi*, H = *Hatvani*, Ho = *Hódmezővásárhelyi*, I = *Indiai*, M = *Madurovics*, O = *Opiiferum*, P = *Pitvarosi*, S = *SC*

larger plants require less inductive cycles and also the crucial length of the inductive period becomes gradually shorter during the vegetation period. Incomplete induction means that either not all treated plants reacted or after the return to short days as an after-effect of the inductive cycles foliar leaf like calyces of teratological type, several cycles of calyces or instead of stamen and pistil primordia vegetative shoot have been observed. Relationship between the number of photoperiodic cycles necessary to complete induction and the length of the crucial period is not quite unequivocal, especially if the *Hatvani*,

Table 4a

Effect of the number of inductive cycles of various length on the onset of differentiation of reproductive organs in 1957/58

Variety	Length of inductive photoperiod, hour	Age of plant at the onset of induction, days	Number of inductive cycles	Appearance of the reproductive growing point		
				from beginning of inductive cycles, days	from emergence, days	Date
H	24	8	23	23	31	Jan. 8
		32	1*	60	92	March 10
		32	2*	60	92	March 10
		32	4*	60	92	March 10
		32	7	15	47	Jan. 24
		32	(13)11	11	44	Jan. 21
	15	8	38	38	46	Jan. 23
		34	6	45	79	Febr. 25
		34	9	32	66	Febr. 12
		34	12	26	60	Febr. 6
S	24	8	23	23	31	Jan. 8
		32	4*	80	112	March 30
		32	11	14	47	Jan. 24
		32	13	13	46	Jan. 23
	15	8	38	43	51	Jan. 28
Ho	24	8	19	19	27	Jan. 4
		29	4*	94	123	Apr. 10
		29	6	16	46	Jan. 23
		29	9	13	43	Jan. 20
		29	(16)11	11	42	Jan. 19
		44	2**	20	54	Febr. 10
				69	123	Apr. 10
	15	8	35	35	42	Jan. 20
		34	6*	89	123	Apr. 10
		34	9*	89	123	Apr. 10
		34	9	25	59	Febr. 5
		34	12	23	57	Febr. 3

Variety	Length of inductive photoperiod, hour	Age of plant at the onset of induction, days	Number of inductive cycles	Appearance of the reproductive growing point		
				from beginning of inductive cycles, days	from emergence, days	Date
O	24	8	17	17	15	Jan. 2
		29	4*	104	133	Apr. 20
		29	6	22	51	Jan. 28
		29	9	18	47	Jan. 24
		29	(16)14	14	43	Jan. 20
	15	8	35	35	42	Jan. 20
		34	12*	99	133	Apr. 20
P	24	8	25	25	32	Jan. 10
		32	4*	91	123	Apr. 10
		32	11	20	53	Jan. 30
		32	13	18	51	Jan. 28
	15	8	38**	43	51	Jan. 28
				115	123	Apr. 10
M	24	8	19	19	27	Jan. 4
	15	8	19	19	27	Jan. 4

* = not enough for induction
** = imperfect induction

SC, and the *Hódmezővásárhelyi*, *Opiiferum* varieties are compared. Comparing the data of the photoperiodical treatments with those of outdoor variety assortment it may be inferred that flowering dates in outdoor seedlings depend rather on the minimum number of inductive cycles required by young plants than on the length of the crucial photoperiod experienced on older plants (Fig. 3), since at the end of April the photoperiods are already longer than the assumedly crucial 14-hour period.

In the experiment several degrees of induction can be distinguished. In some of the cases reproductive primordia appear as early as during the 24- or 15-hour cycles, while in others only after the end of the treatment. It is evident that photoinduction had come to an end before the external morphological changes occurred but the formation of the reproductive organs was greatly accelerated by the inductive photoperiod. Besides, the higher inductive the photoperiod, the less cycles are sufficient for induction. Thus the minimum (crucial) number of given cycles necessary to induction may be somewhat lower than the values represented on Fig. 4. The crucial number of the 24-hour cycles decisively but not very much diminished depending on the age of plants.

In 52-day-old plants we examined only the response of the varieties *Hatvani*, *SC* and *Büdszentmihályi*, this experiment was, however, carried out in the brighter period at the end of January with longer natural days already. If differentiation of buds began after the photoperiodic treatment, the period not only from the beginning of the inductive cycles but from their ending and — in the whole experimental period — also the length of the natural (short) days must be taken into consideration. To such manifold questions our data

Table 4b

Effect of the number of inductive cycles of various length on the onset of differentiation of reproductive organs in 1958/59

Variety	Length of inductive photoperiod, hour	Age of plant at the onset of induction, days	Number of inductive cycles	Appearance of the reproductive growing point: from beginning of inductive cycles, days	from emergence, days	Date
H	24	15	15	15	30	Jan. 2
		39	11	11	50	abt. Febr. 4
		52	7	7	59	Jan. 31
	14	1	67	70	71	Febr. 12
S	24	1	20	20	21	Dec. 24
		15	13	54	69	Febr. 10
		39	17	17	56	Febr. 10
		52	7	8	60	Febr. 10
	14	1	69	72	73	Febr. 14
Ho	24	1	7**	127	128	Apr. 10
				32	33	Jan. 5
		1	16	16	17	Dec. 20
		15	13	13	28	Dec. 31
		39	13	13	52	abt. Febr. 6
	14	1	71	74	75	Febr. 16
O	24	1	20	20	21	Dec. 20
		39	13	13	52	abt. Febr. 6
	14	1	69	72	73	Febr. 14
P	24	1	24	24	25	Dec. 28
		15	19	19	34	Jan. 6
		39	17	17	56	Febr. 10
	14	1	71	74	75	Febr. 16

Variety	Length of inductive photoperiod, hour	Age of plant at the onset of induction, days	Number of inductive cycles	Appearance of the reproductive growing point		
				from beginning of inductive cycles, days	from emergence, days	Date
Bü	24	1	14	14	15	Dec. 18
		39	11	11	50	abt. Febr. 4
		52	7	7	59	Jan. 31
	14	1	44	47	48	Jan. 20
I	24	0	19	21	21	Jan. 6
		39	7	7	46	Jan. 31
	14	0	43	46	46	Jan. 31

** = imperfect induction
H = *Hatvani*
S = *SC*
Ho = *Hódmezővásárhelyi*
O = *Opiiferum*
P = *Pitvarosi*
Bü = *Büdszentmihályi*
I = *Indiai*
M = *Madurovics*

do not supply a satisfactory answer. In some cases, however, the "crucial" number of cycles can be approached from both sides (Table 5).

Crucial light intensity necessary for photoperiodical induction. In winter 1958/59 experiments were conducted with the variety *Hatvani* where plants placed at various distances from the light source were given different light intensity in photoperiods supplemented to 24 hours in the night. The experiment lasted from January 17 to March 7. The beginning of the reproductive phase of plants that received different illumination and the number of internodes on the main axis are shown in Table 6. No doubt that the threshold value of light intensity necessary for photoperiodical induction is exceedingly low. The incandescent lamps, however, served both as source of energy and heat and the distance from them greatly influenced the developmental state of plants as appeared from the dimensions of the largest leaf of plants. Similarly to the induction, growth lagged behind as well and thus there was no difference in the number of internodes, except for the last degree, which can be only explained by the different temperature etc. conditions in the farther (8 meter) end of the greenhouse.

The change in the number of internodes on the main axis depending on photoperiod. Developmental state of plants was indicated beside the age expressed in days also by the number of internodes on the main axis. The

Table 5

Approximate values of the minimum number of inductive cycles

Variety	Photoperiod (hour)	Age of plant at the onset of induction (days)	Minimum number of cycles
Hatvani	24	32	between 4 and 7
	15	34	6
SC	24	32	between 4 and 11
Hódmezővásárhelyi	24	1	abt. 7
		8	between 4 and 6
		44	2
	15	34	abt. 9
Opiiferum	24	29	between 4 and 6
	15	34	12
Pitvarosi	24	32	between 4 and 11
	15	8	abt. 38

final value of the number of internodes attained at the appearance of the generative growing point fluctuated within treatment and variety to a comparatively lesser extent (Table 7). At the 24-hour photoperiod the difference between the two years' data arose from the fact that the light treatment had started in 1957 at the 8th and in 1958 at the 1st day after emergence whereas in natural daylength the deviation could have been caused by the differences in seeding dates and temperature. It deserves attention that the number of internodes of the variety *Madurovics* was highest in outdoor seedlings.

Table 6

The effect of light intensity of supplementary illumination in the night on the inductivity of cycles completed to 24 hours in the case of the variety Hatvani

Seeding date: I. 17

Light intensity (lux)	1700	1500	1100	850	700	550	430	330	300	250	200	160
Mean number of internodes	12.0	11.7	11.7	12.3	11.9	12.2	12.5	12.4	11.7	12.0	12.6	13.4
Age of plant in days	22	22	23	—	—	—	—	—	35	36	36	36
Length of leaf (mm)												
II. 12	50					25						13
III. 7.	50					60						60

Table 7

Final number of internodes on the main axis at the onset of bud differentiation

	Madurovics	*Hatvani*	*SC*	*Hódmezővásárhelyi*	*Opiiferum*	*Pitvarosi*
24-hour illumination						
1957/58	11.4±0.7	11.9±0.8	12.4±1.0	10.9±1.2	11.3±0.8	14.0±0.0
1958/59	9.8±0.6	—	10.7±0.6	8.7±0.6	10.0±0.0	13.2±0.5
15-hour illumination						
1957/58	11.6±0.5	15.8±0.1	16.4±1.0	15.3±1.2	16.5±0.9	20.3±0.9
14-hour illumination						
1958/59	10.0±0.0	19.8±1.3	18.9±1.0	20.7±3.1	19.8±1.6	25.2±1.1
On natural day length						
1957/58	12.4±0.5	27.6±1.4	28.6±1.6	32.4±1.8	35.0±2.8	35.0±1.4
1958/59	13.4±1.7	—	38.0	41.0	45.0	39.4±2.2
outdoor 1957	17.8±1.7	26.6±2.0	28.2±4.3	28.3±2.0	29.2±2.8	25.2±2.7

Discussion

The photoperiodical indifference to daylength in case of summer lettuce varieties is understood by Bremer (1962) in a sense that these do not develop inflorescence even on long days inductive for other varieties. On the contrary, some types of pea varieties as well as of poppy and of other plants, e.g. varieties of the short-day species *Phaseolus vulgaris*, being day neutral generally excel in earliness under the temperate zone, since natural daylength during the crucial section of their vegetation period does not pass beyond the threshold value, and induction is always nearly complete (Kopetz 1956). It is evident that rather heterogeneous phenomena are referred to as day neutrality.

The mechanism of day neutrality in the variety *Madurovics* may be explained in different ways: The plant may either receive in the seed (germ, endosperm) the substance necessary for flowering or there may be lacking a flowering-inhibitor which if present ought to be decomposed by the action of photoinduction. In case of day neutral pea varieties Haupt (1957, 1958) argued in favour of the former, Barber (1959) of the latter theory. It is more likely, however, that at the temperature prevailing in our experiments and at short days induction occurred in the variety *Madurovics*, while at lower temperatures it does only under the influence of a longer photoperiod or at a slower rate. The relatively high number of internodes of the variety *Madurovics* was found outdoors whereas day neutral according to our experiments performed in a greenhouse and its variable height recorded in different years could be explained by the various expressivity of day neutrality. Therefore the effect of a night temperature of about 5—10 °C with 8—12-hour photoperiods should be investigated. The experiments of REATH—WITTWER (1952) in peas also seem to support rather the theory according to which the varieties indifferent to length of day at a night temperature of 60 °F showed unequivocally a long-day response at 50 °F.

The long-day response type has, depending on the inductive photoperiodical threshold, several degrees. When raising the same poppy varieties on various geographical latitudes VESSELOVSKAYA (1933) established that the varieties of southern origin adapted to shorter daylength ranked in the north (in Minsk) very early but remained small sized. Similarly the summer wheats of northern origin suffer, according to DOROSHENKO (1927), much more from short days than the types of Southern Russia. According to BREMER—WEISETH (1961) in North of Norway on the long days of summer radish and spinach varieties grown all over Europe give — on account of early bolting and onions of rapid bulb formation — a satisfactory yield only in case of artificial short-day treatment. Thus the opium poppy varieties of Asia Minor and of the Balkans with their numerous advantageous features do not supply, on account of their extreme earliness, profitable yields in Hungary. This tolerably winterhardy ecotype developed in the course of growing by consequent autumn sowing INCEKARA 1949, BARTOSCH 1929, SÁRKÁNY—ANDRÁSFALVY—F. RIEDEL 1959, UNK 1961).

Temperature, as it is well known, modifies the inductivity of photoperiods for which indirect proofs were obtained in earlier experiments of periodical sowing technique (SÁRKÁNY—F. RIEDEL—ANDRÁSFALVY 1959).

As a proof of interaction of photoperiod and temperature it may be mentioned that Mika's "Yuma" poppy plants originating from India developed flower bud after 53 leaves in photoperiodical chamber at 8-hour photoperiod and 7—24 °C night temperature, while at 15.5—29 °C night temperature they remained vegetative up to their 98th leaf. The same variety when raised at 21 °C temperature from emergence during 14 days on a 24- or 18-hour photoperiod developed 11 $\pm$ 1 internodes, but in plants as old as 14, 30, 45 and 64 days the bud differentiation began uniformly after ten 18-hour cycles. Until the onset of the experiment the plants developed on 8-hour photoperiod and throughout at 18 °C average temperature. The crucial daylength was between 15 and 16 hours at 21 °C but if the intermediary condition of the growing point (3rd stage) is also considered as generative, then, according to the author, also a 10- to 11-hour photoperiod may be sufficient to induce flowering in the greenhouse.

In the present experiment, depending on age and variety of plants, the number of the 24-hour photocycles until bud differentiation was 7—24. There is no doubt that in the late winter natural days were already longer and the fluctuating temperature also influenced photoinduction.

The order of earliness of our poppy varieties was different when they were raised at continuous illumination or in the naturally elongating period of late winter to early spring. There are also examples for the opposite behaviour of different varieties depending on environmental conditions. In the experiment with summer wheat of GRIES *et al.* (1956) and RIDDELL—GRIES (1958) one of the examined varieties was earlier on shorter (8-hour) photoperiod and at lower (60 °F) temperature than the other varieties, while under every other experimental condition the relationship was the reverse.

The development of the photoperiodical response of the long-day poppy is probably a cumulative process. Starting from this assumption we interpreted the effect of temperature and the nature of the various types of response as follows: In the improved varieties with shorter response threshold the product of the response begins to accumulate earlier than in those with higher threshold. At the same time more intensively inductive (longer) photoperiods do not act as definitely on the former, and allow them to grow satisfactorily even on longer photoperiods. This, in a certain respect means a shift toward another type of day neutrality determined by BREMER (1962). Both the threshold value of the length of photoperiod and the effect of photoperiods below the more or less definite threshold on the cumulative process of the development of response change with temperature. The effect of highly inductive, long (18- to 24-hour) photoperiods is largely independent of temperature, but the slowly developing response during shorter (8- to 15-hour) days depends markedly on temperature. High photoperiodical threshold promotes the development of winter hardiness of the plants sown in autumn while under the influence of photoperiodical induction the frost resistance of plants diminishes as demonstrated by RUDORF (1938) on winter wheat and winter barley. Vernalization may have the same effect (TALALAYEV 1936). The variety *Madurovics* is remarkable to be highly susceptible to frost in the autumn seeding.

Vernalization requirement of the examined poppy varieties is, to the effect of winter cereals, either non-existent or must be of no importance as judged from the data of the present experiment, although LECAT (1955) succeeded with cold treatment of the germinating seeds in accelerating flowering and increasing grain yield in an unidentified variety.

Conclusions

The day neutrality of the variety *Madurovics* manifests itself in flowering on short day under the conditions of our experiments.

Local varieties of Hungarian and East Mediterranean origin adapted to winter seeding *(Hódmezővásárhelyi, Opiiferum* and *Büdszentmihályi)* responded stronger both to the 24- and 15-hour photoperiods than improved varieties *(Hatvani* and *SC)* and another local variety *(Pitvarosi)* grown by spring seeding. The two types, however, did not differ clearly in the 14-hour periods of the experiment. The order of varieties changed in respect of transition into reproductive phase when older plants are raised in the months of March and April on natural photoperiods of about 12 hours. Then the markedness of the photoperiodical response manifests itself in a longer critical photoperiod.

The southern (Indian) varieties as far as they can be characterized on the basis of our unique accession and of literary data are also of long-day type, their photoperiodical threshold value being somewhat lower and the markedness of response lags behind that of the local winterhardy varieties, of South-Eastern Europe and Asia Minor.

Acknowledgement

Thanks are due for the varietal lots to Prof. S. SÁRKÁNY, to my colleagues particularly to LUCIA F. RIEDEL as to originators and maintainers of the varietal collection maintained and inbred for several years at the Institute of Applied Botany and Histogenesis of the L. Eötvös University, Budapest, while for making available and having equipped the glass surface, to my colleagues in the Research Institute of Horticulture.

REFERENCES

BARBER, H. N. (1959): Physiological Genetics of *Pisum* II. The Genetics of Photoperiodism and Vernalization. Heredity, **13,** 33—60.

BARTOSCH, B. (1929): Der Mohnbau in Südserbien. Die Ernährung der Pflanze, **25,** 149—155.

BREMER, A. H. (1962): Salat, *Lactuca sativa* L.: In Manual of Plant Breeding, edited by H. KAPPERT and W. RUDORF, *VI*, 258.

BREMER, A. H.—WEISETH, G. (1961): Problems of Vegetable Production in Relation to Day-length on Latitudes 58—70° N. Proc. XVth Int. Hort. Congr., Nice, 1958, 426—435.

DOROSHENKO, A. (1927): Photoperiodism of Some Cultivated Forms with Reference to Their Origin. Bull. Appl. Bot. and Plant Breeding, Leningrad, **17,** 167—220.

GRIES, G. A.—STEARNS, F. W.—CALDWELL, R. M. (1956): Responses of Spring Wheat Varieties to Daylength at Different Temperatures. Agron. Jour., **48,** 29—32.

HAUPT, W. (1958): Die Blütenbildung bei *Pisum sativum.* Z. f. Bot., **46,** 242—256.

HAUPT, W. (1957): Photoperiodische Reaktion bei einer als tagneutral geltenden Sorte von *Pisum sativum.* Berichte DBg., **70,** 191—198.

INCEKARA, E. (1949): Türkiye Hashas Cesitleri ve Bunlarin Tohum ve Afyon Bakimindon Degerleri. Cankaya, 376.

KOPETZ, L. M. (1956): Gibt es tagneutrale Pflanzen? Die Bodenkultur, **8,** 369—373.

LECAT, P. (1955): Sur diverses méthodes du vernalisation du Pavot oeillette. C. R. Acad. Sci., (Paris) **241,** 1984—86.

MIKA, E. S. (1955): Studies on the Growth and Development and Morphine Content of Opium Poppy. Botanical Gazette, **116,** 323—339.

REATH, A. N.—WITTWER, S. H. (1952): The Effects of Temperature and Photoperiod on the Development of *Pea* Varieties. Proc. Amer. Soc. Hort. Sci., **60,** 301—310.

RIDDELL, J. A.—GRIES, G. A. (1958): Development of Spring Wheat. II. The Effect of Temperature on Responses to Photoperiod. Agron. Jour., **50,** 739—742.

RUDORF, W. (1938): Keimstimmung und Photoperiode in ihrer Bedeutung für die Kälteresistenz. Züchter, **10,** 238—246.

SÁRKÁNY, S.—PERCS, E. (1957): Histogenetical Observations in the Stem Tip of *Papaver somniferum* L. Acta Biol. Acad. Sci. Hung., 7, 184—201.

SÁRKÁNY, S.—ANDRÁSFALVY, A.—F. RIEDEL, L. (1959): Data on Growth and Development in Poppy. Acta Agr. Acad. Sci. Hung., **9**, 341—362.

TALALAYEV, E. V. (1936): Contributions to the Methodics of Selection of Winter Wheat for Frost Resistance. Plant Industry in the USSR, **20**, 43—49.

UNK, J. (1961): Őszi-mák termesztési próbálkozások bolgár fajtákkal (Attempts to Cultivate Autumn Poppy with Bulgarian Varieties). Magyar Mezőgazd., Budapest, **40**, 9—10.

VESSELOVSKAYA, M. A. (1933): The poppy. Its Classification and its Importance as an Oleiferous Crop. Suppl. 56. Bull. Appl. Bot. Genet. and Plant Breed. Lenin Acad. Agr. Sci. USSR. Leningrad.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 101—114 (1968)

STUDIES ON THE FORMATION OF MICROFLORA IN THE RHIZOSPHERE OF SUGAR BEET SEEDLINGS

By

P. GYURKÓ

FORESTRY SOIL MICROBIOLOGICAL RESEARCH SECTION OF THE HUNGARIAN ACADEMY OF SCIENCES, UNIVERSITY OF FORESTRY AND TIMBER INDUSTRY, CHAIR OF SOIL SCIENCE — SOPRON

The "slide-method" of ROSSI and CHOLODNY has been used in non-sterile soil to study the amount and the distribution of bacteria multiplying on the roots of sugar beet seedlings grown from seeds that were inoculated and non-inoculated, respectively, with rhizosphere bacteria. The effect of inoculation was still manifest on the roots of two weeks old seedlings. Around the roots an area of a certain diamater was established where the amount of soil microorganisms had been influenced by root secretion. This zone was regarded as the rhizosphere. The extension of the rhizosphere with respect to root parts of different ages and the distribution of bacteria inside the rhizosphere have been quantitatively determined.

Introduction

In an earlier publication (GYURKÓ 1962) the formation of the rhizosphere microflora on roots of sugar beet seedlings inoculated or non-inoculated with rhizosphere bacteria was investigated. In the above paper, however, only the rate of bacterial multiplication on the root surface was studied. In the present publication investigations will be reported, in which changes in the number of bacteria, as influenced by the secretion of seedling roots, have been established not only on the root surface but also in the soil surrounding the roots.

The questions to be answered have been the following: how the rhizosphere microflora is being formed in time and space around the roots of young seedlings; whether or not the rate of multiplication of rhizosphere bacteria on the root surface and around the roots in non-sterile soil can be enhanced by inoculation with rhizosphere bacteria; whether the bacteria that have been introduced by inoculation will follow the track of the growing root, i.e. whether inoculation will affect the formation of the rhizosphere microflora for a longer period of time, or else, will it have an influence of a shorter duration only.

A further purpose of our investigations was to establish the distribution of bacteria on the roots and around them.

Materials and Methods

For the experiments the "slide method" of ROSSI and CHOLODNY (ROSSI—RICCARDO 1927, ROSSI 1928, CHOLODNY 1930) has been used.

In spite of some disadvantages of the method mentioned above (slides inserted into the soil are known to alter the diffusion of subsoil water and of root secretion to some extent, the effect of root secretion on microorganisms can be established only quantitatively and not qualitatively) we have thought that by its use in the demonstration of bacteria on the roots and in the surrounding zone, natural conditions can be imitated to a higher extent than by other indirect microbiological methods.

Sugar beet (var. *Beta 242/53*, bred in Sopronhorpács) plants have been grown in pots in well-mixed and screened non-sterile garden mould. Before sowing, thoroughly cleaned microscopic slides had been inserted into the soil in a stepped manner one below the other so as to

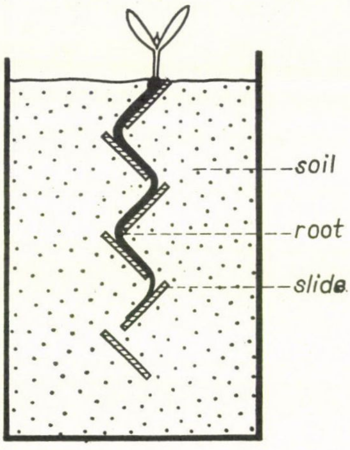


Fig. 1. Schematic arrangement of the experiment

force the emerging roots to grow on the surface of these slides. All the slides used came from the same package to ensure their identical chemical composition and to avoid thereby selective effects due to differences in chemical composition (HORVÁTH 1944). The experimental arrangement is shown schematically in Fig. 1.

The seedlings were grown for two weeks. Then the pots were carefully emptied and the soil was gradually removed from the slides. Before the slides were displaced and taken out the preparations had been fixed by a gas flame. Careful heating with the gas flame was continued until the soil layer under the glass surface became dry. This was established from the fading of the soil. Slides were then taken out and after washing off larger soil particles the preparations were stained and examined in the microscope. On the slides along the roots and root hairs masses of bacteria were visible. In these preparations the distribution of bacteria was well discernible and quantitative studies could be carried out on root parts differing in age and in the soil at given distances from the roots.

On the slides quantitative changes in the bacterium flora could be followed all along the roots, from the root collar down to the root tip. Since during the vegetation period roots grew down as far as the fifth slide, the roots of the two weeks old seedlings and their surroundings were examined in five portions. Further details within individual slides were not investigated. The Tables represent average data obtained by evaluating the slides in their whole width. During the evaluations the number of bacteria in a field of vision of an area of 0.0038465 mm^2 was established. Countings were made along the roots as well as at distances of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 mm from the roots along streaks running parallel to the roots. In this way changes in the number of bacteria were followed in the surroundings of root parts differing in age as well. Along individual streaks as a rule 20 fields of vision were quantitatively evaluated. The Tables contain the average values of these measurements calculated for an area of 1 mm^2. Usually no difficulty was encountered in countings along the streaks at different distances from the roots. While counting along the roots, however, it often happened that bacteria were found to occur in large masses unsuited for a reliable quantitative evaluation. In such cases several smaller areas were counted in the individual fields of vision, and the total number of bacteria in the field of vision was estimated on the basis of several such partial countings.

The method of counting outlined above was used for root parts of plants both inoculated and non-inoculated with rhizosphere bacteria. The inoculations were carried out with 16 rhizosphere bacterial strains that had been isolated from roots of 6 weeks old sugar beet seedlings and subjected to detailed morphological and physiological analyses. Cultures were individually suspended in a saline solution and the suspensions were then mixed. Inoculation was done by submerging non-sterilized seed glomerules into the mixed suspensions for one hour. The mixed suspensions contained about 4×10^{11} bacterial cells per ml. The non-inoculated control consisted of seed glomerules treated with sterile saline solution in the same manner. The seeds were sown immediately after the treatment. With the plants grown from both inoculated and non-inoculated seeds 5 undamaged roots were taken and those slides were subjected to analysis which following visual inspection, seemed to be most suitable for counting after preparation (washing, staining).

Results

To show the distribution of bacteria along the roots some original microphotographs are presented. The largest masses of bacteria occur on the root surface itself (Figs 3, 4, 5, 6, 9). Larger bacterial colonies are to be found along the root-hairs as well (Figs 10, 11, 12, 16), but in many cases only few bacteria, if any, can be observed along the root-hairs (Figs 13, 14). At any rate, in the zone surrounding root-hairs obviously much less bacteria are living than on the roots themselves and outside this zone their number decreases even more rapidly with increasing distances from the root.

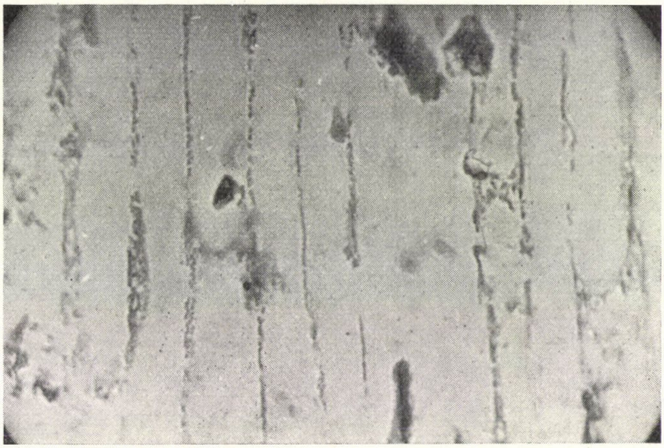


Fig. 2. Cellular structure of the root surface as revealed by the distribution of bacteria. (Magnification, about 1000 ×)

Availability of space seems to be an important factor influencing the distribution of bacteria. It was namely observed that whenever the roots had been closely attached to the slides the only places where bacteria could be found were the longitudinal interspaces between the cell rows on the root surface. That is why the distribution of bacteria along the root tracks shows a

Fig. 3. Bacterial masses accumulated along a root track. (Magnification, about 1000×)

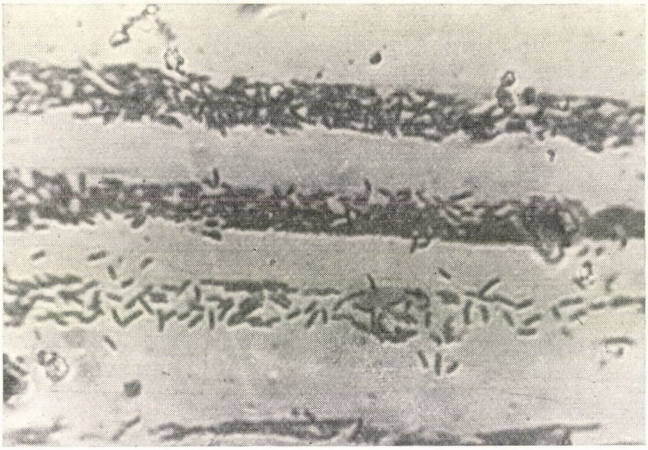


Fig. 4. Morphologically identical rod-shaped bacteria along the longitudinal grooves of the root surface. (Magnification, about 1600×)

longitudinal striation (Figs 3, 4 and 6). Sometimes even the cellular structure of root surface is reflected in the distribution of bacteria on the slides (Fig. 2). At the edges of the main roots obviously larger interspaces were available since bacteria were found to occur in large masses, especially at the bases of the root-hairs (Fig. 9).

As a rule bacteria of identical morphology occurred in smaller or larger colonies which covered the roots by forming a mosaic pattern (Fig. 7). The diameter of larger colonies was as long as several tenths of millimeter and by examining these colonies in the microscope the whole field of vision turned

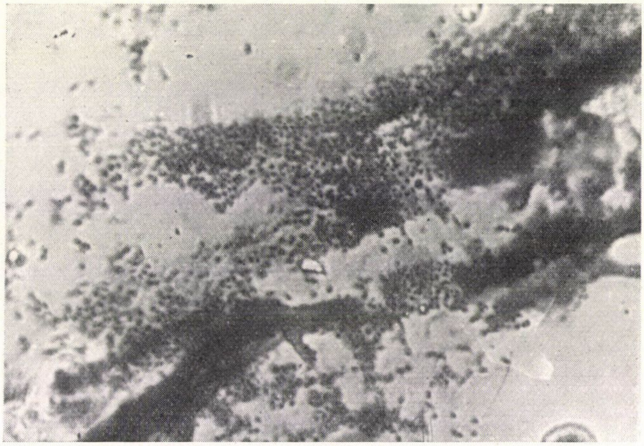


Fig. 5. Portion of a large colony of coccus-like bacteria along the root. (Magnification, about 1600×)

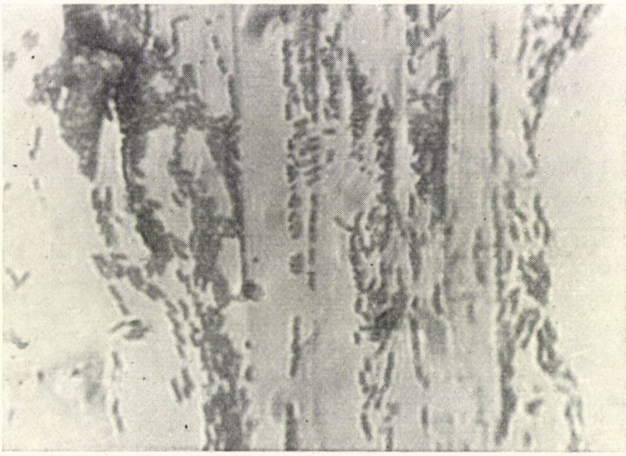


Fig. 6. Rod-shaped bacteria along the root. (Magnification, about 1600×)

out to consist of bacteria of identical morphology (e.g. Figs 4, 5, 10 and 11). At places where there was more interspace available, e.g. where the root was not growing directly on the surface of the slide and where there was probably more water present, the bacteria did not form colonies but rather occurred individually, intermingled (Fig. 8). This phenomenon may be due to the fact that most of the rhizosphere bacteria, primarily in the initial stage of their life cycle, are motile.

In the close vicinity of root tracks no fungi or actinomyces were found. They seldom occurred in the zone of root-hairs (Figs 15 and 16).

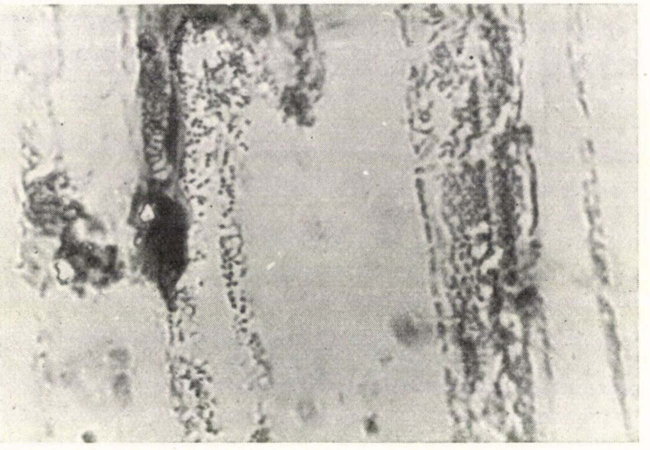


Fig. 7. Small colonies of morphologically different bacteria along the root. (Magnification, about 1600×)

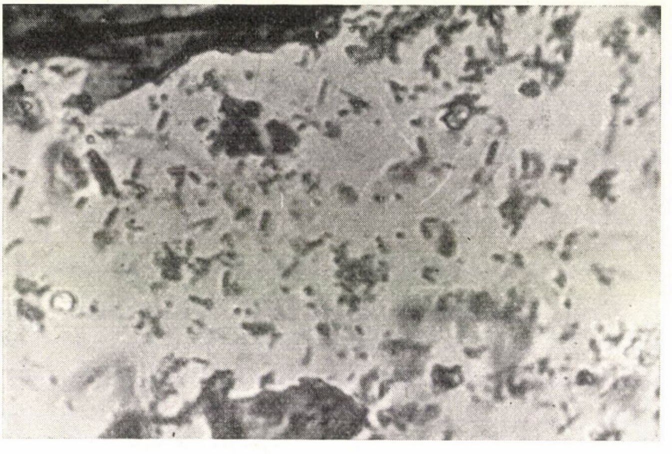


Fig. 8. Individually intermingled, morphologically different bacteria. (Magnification, about 1600×)

No apparent differences in the number of bacteria occurring on roots have been established between inoculated and non-inoculated plants. Only detailed quantitative analyses did reveal some difference.

It has to be stressed that during the microscopic examination of the slides bacteria were very rarely found to occur on the surfaces of roots or root-hairs attached to the slides. This phenomenon suggests that bacteria are much more easily fixed to mineral soil particles or to glass surfaces than to plant parts. It is very probable, therefore, that by rinsing the slides, part of the bacteria

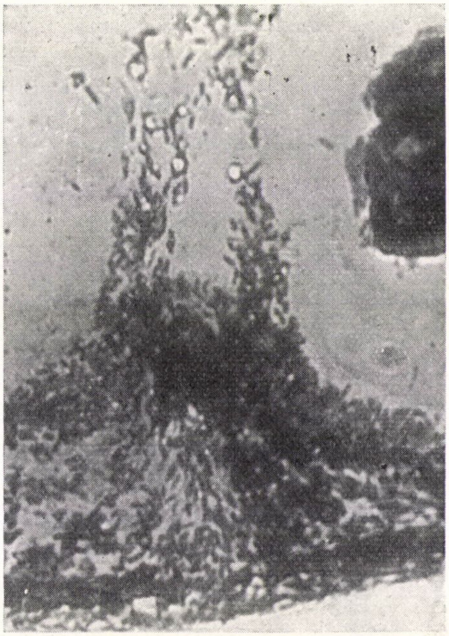


Fig. 9. Masses of bacteria grown at the base of a root-hair, near the main root. (Magnification, about 1600×)

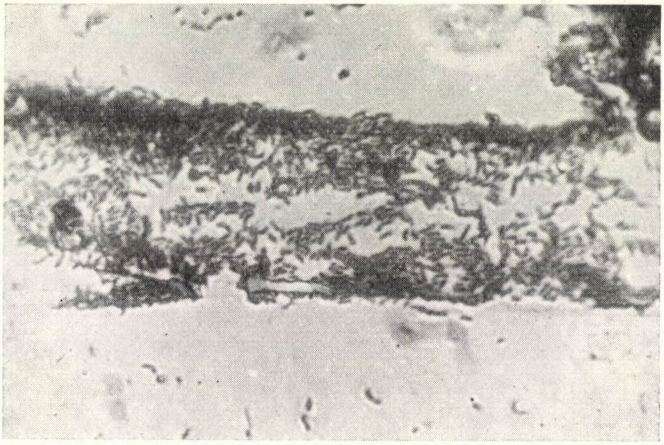


Fig. 10. Portion of a large colony of morphologically identical bacteria, near the base of a root-hair. (Magnification, about 1600×)

attached to soil particles were also removed. This would mean that there were actually more bacteria present around the roots than what is seen in the pictures and what was established from the counts.

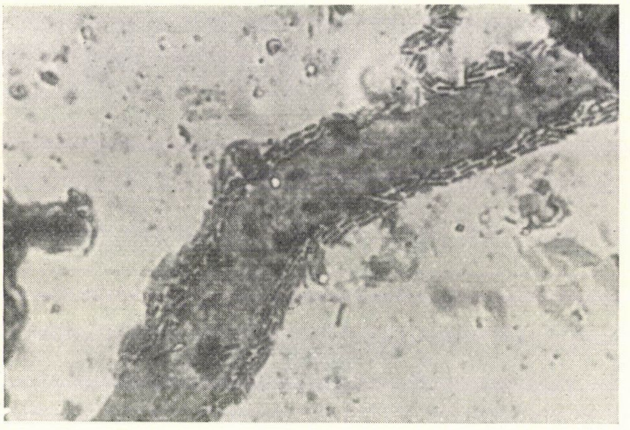


Fig. 11. Middle part of a root-hair with morphologically identical, rod-shaped bacteria at both sides. The root-hair itself was fixed to the slide. (Magnification, about 1600×)

Fig. 12. Colonies of rod-shaped bacteria at both sides of a root-hair. The root-hair was not fixed to the slide. (Magnification, about 1600×)

From what has been said above it is quite certain that the picture obtained by counting the bacteria on the slides does not reflect quite truly the natural conditions. However, since this inadequacy holds equally for every slide, there seems to be no reason why the results obtained with the individual slides should not be comparable.

Tables 1 and 2 represent the results of the quantitative analyses. Since in the root tracks and in the zone up to a distance of some millimeters from the roots very few fungi and actinomyces were found, only the numbers of bacteria are shown in the tables for both inoculated and non-inoculated plants.

Table 1

Number of bacteria on the root of inoculated plants and at different distances from the root

(calculated for an area of 1 mm²)

Signs for the root parts	Number of bacteria on the root	Number of bacteria at a distance of 0.5	1.0	1.5	2.0	2.5	3.0	3.5
		mm from the root						
B_5	321.071	52.515	40.036	17.158	10.399	10.399	10.659	10.139
B_4	257.116	31.197	28.077	17.678	12.738	10.399	9.879	11.178
B_3	184.843	26.257	11.958	10.139	13.778	9.359	10.919	10.139
B_2	140.387	12.738	11.438	9.619	9.099	10.139	9.879	9.099
B_1	52.515	10.399	10.139	9.879	8.839	9.359	10.659	9.359

Table 2

Number of bacteria on the root of non-inoculated plants and at different distances from the root

(calculated for an area of 1 mm²)

Signs for the root parts	Number of bacteria on the root	Number of bacteria at a distance of 0.5	1.0	1.5	2.0	2.5	3.0	3.5
		mm from the root						
K_5	251.657	47.575	41.336	36.916	18.458	11.698	11.698	10.659
K_4	244.897	27.817	15.078	15.078	9.619	10.919	9.359	10.139
K_3	112.049	22.357	10.139	10.399	10.139	10.139	9.619	10.399
K_2	49.395	13.258	10.399	11.178	10.659	10.659	9.359	10.399
K_1	43.416	9.879	9.619	9.879	8.579	10.919	9.619	9.879

With both inoculated and non-inoculated plants younger root parts contain less (B_1, B_2 and K_1, K_2), older root parts more (B_4, B_5 and K_4, K_5) bacteria. Consequently, as the roots grow older, rhizosphere bacteria show a parallel increase in number. It may be supposed that up to an age of 14 days the nutrient absorbing and secreting activity of the roots steadily increases and that the observed change in the population trend of the bacteria is due to enhanced secretion.

With increasing horizontal distances from the roots bacterial cell number gradually decreases to reach finally a constant level. This relatively low level equals that of the soil without roots. At the height of older root parts (e.g. B_5, K_5) this level was reached at a fairly long distance of about 2 to 2.5 mm, whereas at the depth of younger roots (e.g. B_2, K_2) this low number of bacteria was attained much closer to the roots. Down at the level of the root tips the

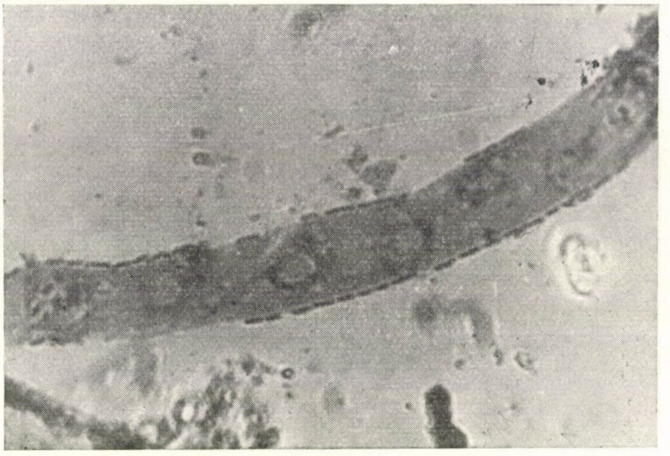


Fig. 13. Middle part of a root-hair with bacteria in single rows at both sides. (Magnification, about 1600×)

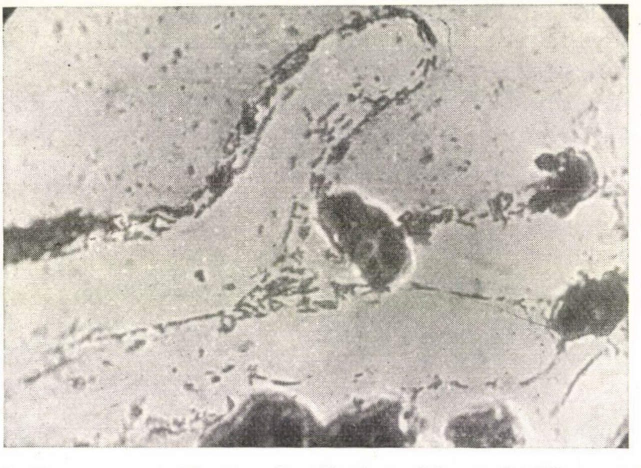


Fig. 14. Root-hair tips as revealed by the distribution of bacteria. The root-hairs were not fixed to the slide. (Magnification, about 1000×)

same number of bacteria were found quite close to the roots and at a further distance.

At a distance (3 to 3.5 mm) that lies outside the range of influence of the roots no appreciable change in the number of bacteria was found with increasing depths.

By using the data of the Tables changes in bacterial cell numbers along a vertical plane section through the roots and their surroundings are graphically represented (Figs 17 and 18).

Fig. 15. Hypha of a fungus near a root-hair and a small bacterial colony between the two. (Magnification, about 1600×)

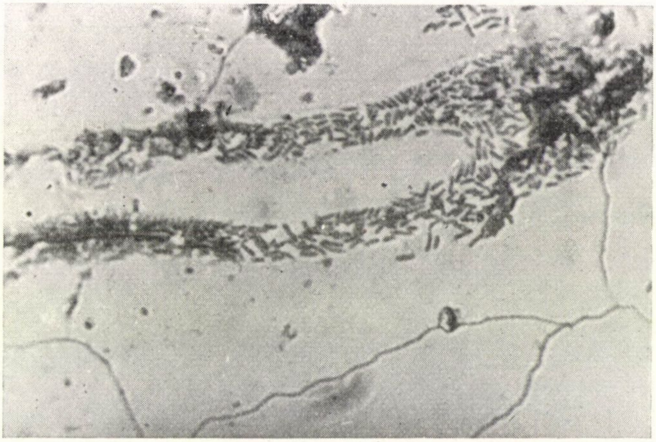


Fig. 16. Bacterial colony surrounding the tip of a root-hair in the form of a cap, farther some hyphae of actinomyces are visible. The root-hair itself was not fixed to the slide. (Magnification, about 1600×)

Bacterial densities in the soil were plotted as mirror images representing the right and left sides with respect to the root taken as the axis. The distances in the horizontal direction were plotted on a larger scale than the data on the vertical axis. Bacterial density (cell number per mm^2) was indicated by corresponding line spaces in the shadings of the individual squares (see the captions to the corresponding figures). The dotted lines in the graphs stand for the edge of the rhizosphere, i.e. the zone, where, according to our results, root secretion has an influence on soil microorganisms. Around older root parts

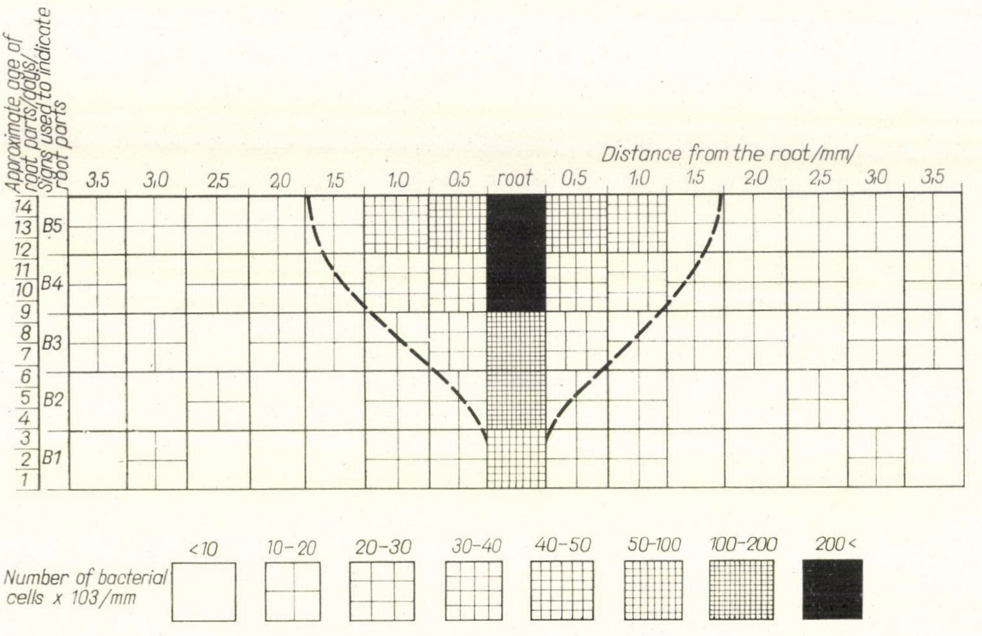


Fig. 17. Density of bacteria on an inoculated root and in its surroundings

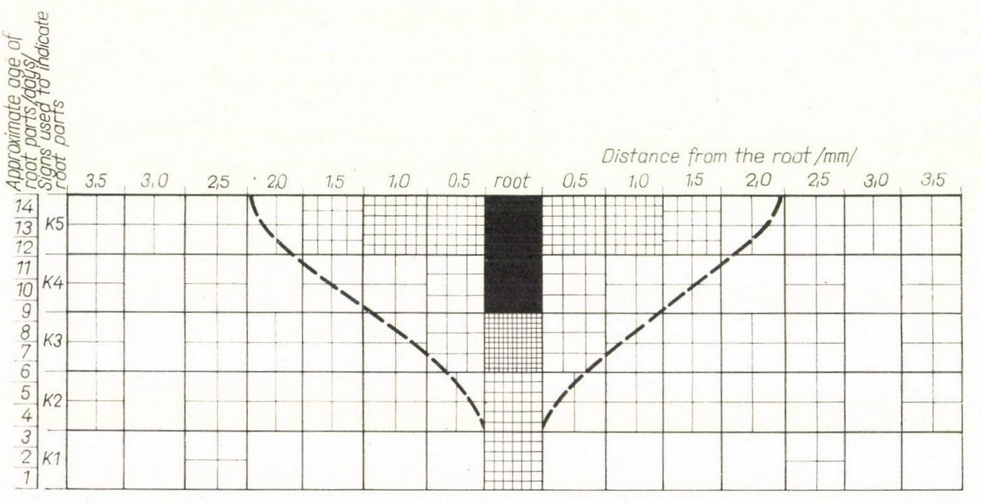


Fig. 18. Density of bacteria on a non-inoculated root and in its surroundings

(B_5, K_5), which apparently exhibit a higher rate of secretion, this zone is wider and becomes gradually narrower as we approach younger root parts. Consequently, the rhizosphere should not be regarded rigorously as being a zone that extends from the root to a fixed distance limit. The extension of the rhizosphere is always dependent upon the actual amount and diffusion rate of root secretion. Of course, the limits found are not sharp, either. There is namely, as shown in the present paper, a gradual transition even within the rhizosphere: bacterial counts decrease gradually with increasing distances from the root. This further indicates that zones being closer to the roots are influenced by bacterial secretion to a higher extent than those being further away.

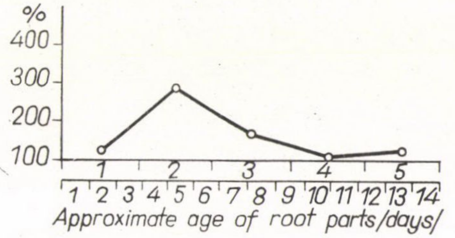


Fig. 19. Number of bacteria on the root parts of inoculated plants, expressed as the percentage of that on corresponding root parts of non-inoculated plants

For the above reason no attempt has been made to subdivide the rhizosphere into further zones. This would have been a very artifical way of approach and still the quantitative method used would not have given unequivocal information.

On the root parts of plants grown from inoculated seeds there were consistently more bacteria present than on comparable root parts of plants grown from non-inoculated seeds.

For a better illustration of the results the number of bacteria from the root parts of inoculated plants has been expressed as the percentage value of the number of bacteria found on the root parts of non-inoculated plants [e.g. $(B_5 : K_5) \times 100$] and represented graphically (Fig. 19). It may be seen that the greatest difference occurs with the root parts No. 2, i.e. with those being 4 to 5 days old. In this case there are three times as many bacteria on the inoculated roots as on the non-inoculated ones. Gradually this difference becomes less with increasing age of the root parts. This means that bacterial population on the inoculated and non-inoculated root parts reaches more or less the same level in about two weeks. These findings are in a good agreement with our earlier data obtained with a different method (GYURKÓ 1962). The great difference observed with young roots may be due to the fact that the multiplying rhizosphere bacteria being introduced by inoculation follow the track of the roots of plants grown from inoculated seeds and as soon as root secretion begins, they start to multiply rapidly. On the other hand, the formation of the rhizosphere microflora on the roots of non-inoculated plants will slow down as a result of selection in the soil.

From the foregoing it follows that the effect of inoculation even in non-sterile soil extends to at least some weeks rather than to some days. It has been namely shown in the present paper that the plants grown from inoculated and non-inoculated seeds, respectively, and exhibiting clear-cut quantitative differences in bacterial population were two weeks old.

In zones surrounding the roots no real differences in the number of bacteria have been found between inoculated and non-inoculated roots.

Even if the data of Tables and graphs suggest that in zones being at a distance of 0.5 mm from the roots bacteria start to multiply slower with the non-inoculated roots than with the inoculated ones and that the limit of rhizosphere at the highest level (K_5) is farther away from the roots with the non-inoculated plants than with the inoculated ones (B_5), these differences do not seem to be essential. We rather think that the inoculation of seeds with rhizosphere bacteria will have its primary effect on the number of bacteria which occur on the root surface.

REFERENCES

CHOLODNY, N. (1930): Über eine neue Methode zur Untersuchung der Bodenmikroflora. Arch. Mikrobiol., **1**, 620–652.

GYURKÓ, P. (1962): Vizsgálatok a gyökérfelületi mikroflóra kialakulásáról cukorrépa csíranövények gyökerén (Studies on the Formation of Microflora on the Root Surface of Sugar Beet Seedlings). A Növénynemesítési és Növénytermesztési Kut. Int. Közl., *II*/**1**, 95–107.

HORVÁTH, J. (1944): A talaj mikroszervezeteinek általános qualitativ és quantitativ kimutatási módszerei és értékelésük (The Evaluation of General Qualitative and Quantitative Methods Used for the Demonstration of Soil Microorganisms). Múzeumi Füzetek, *II*/**2–4**, 236–247.

ROSSI, G.–RICCARDO, S. (1927): L'esame microscopico e batteriologico diretto del terreno agrario. Nuovi Annali dell'Agricoltura, **7**, 457.

ROSSI, G. (1928): Die direkte bakterio-mikroskopische Untersuchung des Ackerbodens. (In Festschrift anlässlich des siebzigsten Geburtstages von JULIUS STOKLASA. Berlin. P. Parey.)

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1–2), pp. 115–129 (1968)

DATA ON THE POSSIBILITIES OF CONTROLLING POTATO VIRUS

IV. EXAMINATION OF THE SUMMER PLANTING METHOD

By

J. HORVÁTH

RESEARCH INSTITUTE FOR PLANT PROTECTION, BUDAPEST

In a series of reports and in this final paper the author has treated the agrotechnical problems of the struggle against potato viruses in the last decades and evaluated the results in which, however, no complete agreement has yet been reached. He determined virus infection, mean productivity, moisture and dry-matter content, amount of starch and vitamin C and the sugar content of certain potato varieties commonly grown in Hungary. In addition to this the infestation biology of virus vectors — aphids — and the questions of the storability of certain potato varieties were treated. During the examination of the individual agrotechnical methods (German, improved German, Dutch and summer planting) it was discovered that in comparison to the results of the 1961 examination of experimental potato varieties (basic stock) the value of virus infection had reduced in regard to the average of the varieties.

Introduction

The seed potato producing method, the so-called "summer planting" method devised to stop the physiological and virus degeneration has had since the publication of the fundamental report of MARX and MERKENSCHLAGER in 1932 a past of more than three decades. Observations on this method were however made even earlier (GRAM 1923) and since then numerous papers have been published which try to clarify the questions of this method.

During the "first period" ending in 1940 (not taking the pertinent Soviet literature into account) the reports were made by the German school and all agreed that summer planting generally had a negative effect on the quality and quantity of the crop (BERKNER 1933, 1939, WARTENBERG 1937, GEYER 1939, SIMON 1939, SZIRMAI 1939 etc.).

The study of the ecological effects was more intensive in the initial phase of the first period than the research on viruses, although even in this respect speedy progress was started by the studies of APPEL (1907), ORTON (1914), QUANJER *et al.* (1919), SCHULTZ—FOLSOM (1925), BŐHME (1933), KÖHLER (1934, 1936), WARTENBERG *et al.* (1935) and HEY (1938).

Alongside of the steadily increasing virological knowledge the ecological explanation of the etiology of degeneration also changed (KŐHLER 1936, PROFFT 1940, OPITZ 1940, SESSOUS—PIELEN 1942). Research in vector biology (HEINZE 1939, WATSON—ROBERTS 1939) clarified the essence of the role played by the dynamics of aphid infestation in transmitting the viruses, the concepts of "persistence" and "non-persistence" being of basic character in controlling the virus vectors. Nevertheless the results of these extensive experiments were disputable because of the independent exogenous factors (e.g. weather conditions influencing the swarming of vectors). Still after the 1940s the opinion arose that the summer planting method was unsuitable for stopping the infective irreversible process of degeneration as well as other harmful economic, biological and pathological results.

While it has been proved in many countries that because of its disadvantageous properties the summer planting method is not useful for producing healthy seed potatoes of good quality, papers by LYSENKO and his followers in the Soviet Union have stated the value of the summer planting method in the struggle against potato degeneration. The theoretical basis of this was set down by LYSENKO (1949, 1953) whose studies were since then subjected to much criticism.

During the "second period" beginning with LYSENKO's reconsideration of the question (thus from the 1950s) efforts to revise the summer planting method strongly increased. In the Soviet Union the followers of LYSENKO (NEMCHIN 1963, FAWOROV 1953, FAWOROV *et al.* 1961, FAWEROV—KOTOV 1965, PONOMARENKO 1962, RUDENKO 1960, BEZPALÜJ 1963, SOKOLENKO 1963, AVAKYAN 1963, SOKOL—KOLESNIK 1963, NESTERENKO 1964, STAYKOV 1964, KOTOV 1964 etc.) still hold that the summer planting method is a valuable process in preventing potato degeneration. At the same time other Soviet researchers believe that the summer planting method is not useful, because of its negative effects, for hindering degeneration (LINNIK 1955, SUHOV 1956, BUKASOV 1958, NURMISTE 1958, ROZALIN 1960, KRUVECKUY 1960, GOLDIN—ELISEEVA 1961, CHESNOKOV 1961, VOLKOV 1963, ZUKOVA—PISAREV 1964 etc.). The scope of this study does not permit to critically evaluate individual reports though it is worth-while to call attention to some more important publications without even trying to make a complete listing of them.

In the past one and a half decades the researchers of various countries were unceasingly working on the topic. The question has been treated in Germany (KÖNNECKE 1951; APPEL 1952, 1953; SCHICK 1952; SCHLEUSENER 1953; SCHLEUSENER—GOERLITZ 1952; WARTENBERG 1954; HEY—RAMSON 1955; GOERLITZ 1955*a*, *b*; LÜDDECKE 1956, 1957; FRŐHLICH—HENKEL 1957; RAMSON 1959; SCHWEIGER 1961; KLINKOWSKI—KEGLER 1962, SCHMELZER *et al.* 1963; ULRICH *et al.* 1963 etc.), in Austria (WENZL—DEMEL 1952, DEMEL—WENZL 1953; WENZL 1950, 1953, 1955, 1956*a*, *b*, 1963, 1964, 1965*a*, *b*; SCHREIER 1953; STEINECK 1955; MAIERHOFFER 1963 etc.), in Poland (BIRECKI—GABRIEL 1964; GABRIEL *et al.* 1964), in Czechoslovakia (POZDENA *et al.* 1954; ZADINA—VOTUPAL 1953; HLAVAC 1958; JERMOLJEV—PRUSA 1961; LABOUNEK 1963), in Bulgaria (KOVACHEWSKY 1954), in Roumania (FODOR et al. 1963), in Italy

(Fabiani 1954), in Spain (Archimovitsch 1952, cit. Wenzl 1955), in France (Dubuffet 1954; Barbier 1962), in Switzerland (Münster 1954), in England (Broadbent *et al.* 1952; Broadbent 1955), in Holland (De Jong et al. 1952), in Israel (Slomnicki 1961), in Argentina (Tizio 1962).

In brief, the publications of the researchers from the listed countries concluded that the negative effects which had been, in their essence, clarified during the research of the first period outweighed the few positive results of the summer planting experiments.

In Hungary the ecological research beginning in the 1950s primarily concerning summer planting (Barsy 1950*a*, *b*, 1954; Gyires 1954; Hinfner 1956; Király 1950*a*, *b*; Koltay 1953; Rédey 1951*a*, *b*; Somorjai *et al.* 1952; Somorjai 1954; Somos 1952; Szalay—Lusztig 1954; Szabó 1952; Nyéki 1960; Tamássy—Barna 1963) or the role of soil chemistry and biochemical factors in potato degeneration (Béres 1960, 1963*a*, *b*, *c*) have made great contributions to science. Although this period had results, it must be admitted that only a few scholars treated virus diseases and in general the role of viruses. In this respect the only exceptions are Szirmai (1947, 1950, 1953, 1954, 1956, 1958*a*, *b*, 1959, 1960, 1963) and the more recent school of his followers (Solymosy 1957, 1962; Horváth 1958*a*, *b*, 1960, 1962*a*, *b*, *c*, 1963*a*, *b*, 1964, 1966*a*, *b*, 1967*a*, *b*; Horváth—Solymosy 1962; Horváth—Hinfner 1964; Sárvári 1960; Hinfner 1960, 1963; Teichmann 1959, Petróczi 1962; Borus 1965; Forgó 1962, Réthy 1964 etc.). The most recent researches (Wenzl 1963, 1965*a*, *b*) criticize the role of ecological factors in causing the formation of thin, thread-like sprouts and colletotrichum [*Colletotrichum atramentarium* (B. et Br.) Taub.]. Wenzl holds that these are the results of the stolbur virus spreading throughout Europe, certain related yellow viruses (aster yellow virus) and other viruses.

The new Wenzl interpretation of the whole question does not contradict the classical observations disclosed by the works of Gilbert (1923), Coons—Cotila (1923) and Muncie (1943) in North America and in more recent years by the publications of Blattny *et al.* (1954), Bojnansky (1957), Klinkowski (1958), Valenta (1959) and Kovachewsky (1964).

Material and Methods

Our experiments were performed on the examined potato varieties we had reported on in previous papers (Horváth 1966*c*, *d*, *e*). During April we removed the winter sprouts from the different varieties. Then after the May dormancy the plants of the selected stock were forced in the beginning of June. The different varieties were planted on July 1 as the main crop in plots of 100 plants with 7 treatments and 4 replicates at the test fields of the Agricultural College of Keszthely. Selection was made twice during the experiments (on July 30th and August 28th).

Results

1) *Virus infection.* Throughout our experiment we determined the degree of virus infection of the individual varieties during the second year of production (Table 1). From the results it can be seen that in comparison to the spring-planted controls the percentage occurrence of the individual virus among plants has generally risen. In comparison to the spring-planted control, the average infection of potato virus Y (PVY) and potato leaf-roll virus (PLRV) among the species rose to 29 per cent and 14 per cent respectively. The mechanically spreading potato virus X (PVX) increased by 62.2 per cent and potato virus S (PVS) by 12.5 per cent. That the mechanically-spread viruses may further infect the plants as the result of latent infections during the course of agrotechnical work is not new and in such cases the rise of infection should not come as a surprise.

The rise of PVY spread both by vectors and mechanically as well as the rise of PLRV spread only by vectors can be attributed to the fact that the aphid infestation was still intensive on July 18th. Borus *et al.* (1965) gave the aphid populations per 100 plants of the individual studied varieties on July 18th as follows:

Gülbaba (36,582), *Somogyi Korai* (9,660), *Kisvárdai Rózsa* (1,830),
Somogyi Kifli (87,631), *Mindenes* (19,880), *Somogyi Sárga* (120).

The aphid population was composed of *Aphis nasturtii* Kalt. (99 per cent), *Myzus persicae* Sulz. (0.9 per cent) and *Aphis gossypii* Glov. (0.1 per cent). Until most recently we have considered the *Myzus persicae* Sulz. to be the most important and other aphid species only secondary as virus vectors. According to the data of Gabriel (1959, 1961) it has been noted that in Poland the main spreader of PVY is *Aphis nasturtii* Kalt. and *Aphis frangulae* Kalt. while the *Myzus persicae* Sulz. plays the most important role in the spread of PLRV.

Thus we should have no doubts that a vector infestation with such a high number of individuals on the newly sprouted young potato plants has initiated a further virus increase among the potato stock. We did not consider it useful to delay the planting because of the advanced sprouting ability of the varieties and in view of the frequent early autumn frosts in the vicinity of Keszthely. The delay of the planting time might have brought about serious consequences since the warm, dry August weather on one hand would have slowed down the development of potatoes, and reduced the resistance following the infection of the plants and on the other hand — as it has been noted — the middle of August saw a strong infestation of aphids. It is worth-while to mention that during the summer planting we sporadically found plants susceptible to colletotrichum [*Colletotrichum atramentarium* (Berk et Br.) Taub.] and fusarium [*Fusarium oxysporum* Schlecht] infections; these were carefully removed during selection. The careful selection done among both the viral and fungi affected plants resulted in that during winter storage, *Gülbaba* and *Kisvárdai Rózsa* — unlike other varieties — had strong thread-like sprout formation already in January.

During the examination of all the experimental varieties it was noted that in case of *Gülbaba* and *Kisvárdai Rózsa* — which had frequently exhibited thread-like sprout formation — the examination of the halved tuber did not reveal symptoms of "ring disease"), i.e., the browning of the vascular bundles characteristic of fusarium. Our hypotheses of the previous year, i.e., that the wilted plants had been the result of fusarium infection, were not proved. The characteristic rubber-like wrinkling and softening of the colletotrichum and fusarium infected tubers could be observed in a larger percentage than the sporadic infections during the growing period. Among the four other varieties *(Somogyi Kifli, Mindenes, Somogyi Korai, Somogyi Sárga)* in which the characteristic phenomena of the fungi could be observed to an equal extent during the growing period no changes could be observed after similar storage.

Afterwards we selected very carefully the *Gülbaba* and *Kisvárdai Rózsa* varieties and only tubers proving free of pathological changes were planted. Because of the careful selection among the two named varieties we could only obtain plots of 50 plants which ultimately on account of poor sprouting (Table 1) and the appearance of disease symptoms (leaf roll, deformations, dwarfed growth etc.) were entirely selected out. According to the earlier hypotheses, the

Table 1

Results of virus examination in the second planting year (1963)

Name of variety	Occurrence of viruses in percentage								
	PVX		PVY		PVS		PLRV		Plants selected 1962
	Sp[a]	C[b]	Sp[a]	C[b]	Sp[a]	C[b]	Sp[a]	C[b]	
Somogyi Kifli	8	6	12	7	45	40	15	11	25
Gülbaba	Ne[c]	21	Ne	6	Ne	50	Ne	21	31 (80—100)[d]
Kisvárdai Rózsa	Ne	12	Ne	10	Ne	36	Ne	20	38 (70—100)[d]
Mindenes	3	2	2	2	36	38	23	20	14
Somogyi Korai	4	2	12	10	43	31	13	12	20
Somogyi Sárga	5	3	10	8	38	35	28	28	16

Notes: *a)* Summer planting
b) Control (spring planting)
c) Not examined
d) The first number in brackets expresses in percentage the unsprouted plants in the 1963 second planting year and the second number expresses that the named variety, in consequence of drooping and serious degeneration, was entirely removed in 100 per cent.

pathological changes made manifest by the dry August weather were due to fungi and physiological damage.

Our present knowledge makes it imaginable that the serious degeneration appearing in the second year of growth can be — in addition to physiological and fungi pathological causes — attributed to different viruses (stolbur or other virus types causing similar symptoms of wilt as e.g. parastolbur, meta-stolbur, aster yellow virus etc.) and the occurrence of the phenomenon is due to the possible over-sensitivity of early *Gülbaba* and middle-late *Kisvárdai Rózsa* against the mentioned *Chlorogenaceae* virus group.

Table 2

Yield of varieties and the grouping of tubers according to standard measurements
(E = elongated tuber variety, R = rounded tuber variety)

Name of variety and date of harvest 1962	Average yield per plant dkg	Standard measurement[b] mm	Standard measurement %
Somogyi Kifli[E]		0– 34	45.1
25. 10	15	35– 79	29.5
	(–25)[a]	80–100	23.8
		101–120	1.6
		above 121	—
		0– 34	40.9
Gülbaba[E]		35– 79	31.6
25. 10.	19	80–100	25.2
	(–9)	101–120	1.3
		above 121	1.0
		0– 34	26.5
		35– 79	40.2
Kisvárdai Rózsa[E]	92	80–100	20.2
25. 10	(–10)	101–120	8.9
		above 121	4.2
Mindenes[R]		0– 39	52.4
25. 10.	105	40– 60	45.8
	(+9)	61– 80	1.8
		above 81	—
Somogyi Korai[R]		0– 39	44.9
25. 10.		40– 60	51.9
	55	61– 80	2.3
	(–18)	above 81	0.9
Somogyi Sárga[R]		0– 39	34.2
25. 10.	110	40– 60	46.8
	(+15)	61– 80	17.9
		above 81	1.1

Note: *a)* The number in brackets indicates the yield per plant of the spring-planted controls.
b) According to the Hungarian standard No. MSZ (6377) 1960.

2) *Yield.* During the examination of yield we found that with the exception of the *Mindenes* and *Somogyi Sárga* varieties the average yield per plant has reduced in comparison to the spring-planted controls (Table 2). Among the early varieties *(Somogyi Kifli, Gülbaba, Somogyi Korai)* the average yield per plant was 29 dkg which on the average means a 17 dkg reduction compared to those planted in the spring. Among the late-maturing varieties *(Kisvárdai Rózsa, Mindenes, Somogyi Sárga)*, *Mindenes* and *Somogyi Sárga* gave an average yield per plant of 107 dkg which in regard to the average of the two varieties signifies an increase of 12 dkg over the spring-planted control. *Kisvárdai Rózsa*, on the other hand, showed an average decrease of 10 dkg in comparison to the spring planting. The results of the distribution of the individual tubers according to standard measurements show that the number of elongated tuber varieties in the 80—100 mm category has increased in comparison to the spring planting, but markedly decreased in the 35—79 mm category (Table 2).

The practical experience that during the summer planting the size of the tubers per plant increases at the cost of their number was not proved in this experiment.

Table 3

Results of the content analysis of potato varieties

Name of variety	Water content %		Dry-matter content %		Total sugar content % in invert sugar	
	Sp[a)]	C[b)]	Sp[a)]	C[b)]	Sp[a)]	C[b)]
Somogyi Kifli	75.2	73	24.8	27	0.91	0.66
Gülbaba	78.4	77.8	21.6	22.2	0.71	0.64
Kisvárdai Rózsa	76.2	74	23.8	26	0.68	0.50
Mindenes	72	70.2	28	29.8	0.89	1.14
Somogyi Korai	78.8	77.6	21.2	22.4	0.34	0.29
Somogyi Sárga	76.6	74.2	23.4	25.8	1.03	0.99

Note: *a)* Summer planting
b) Control (spring planting).

3) *Examination of dry-matter and moisture content.* This examination was carried out after the individual potato varieties had completely ripened (Table 3). Their water content in regard to the control increased during the summer planting whereas the dry-matter content reduced. The examination of the total sugar content of the summer-planted varieties — with the exception of the *Mindenes* variety — yielded higher values.

Results

The Dutch method (= DM) has given the best results so far, provided the stems had been removed before the infestation of vectors. In this case virus infection was reduced by 54.9 per cent. Virus infection was reduced by 39.7 per cent in case of the German method (= GM), by 47.1 per cent in case of the improved German method (= IGM) and by 26.8 per cent when employing the summer planting method (= SPM). It is interesting to note that these methods (GM, IGM, DM, SPM) resulted in a 33.7 per cent reduction of virus infection in comparison to the second-year control plots grown during the same year, whereas the summer planting method shows an increase of 29.4 per cent relative to the control. An examination of the effect of the individual agrotechnical methods shows that PVX reduced by 56 per cent in the second summer-planted crop in comparison to the infection of the basic stock, while the GM, IGM and DM showed reductions of 43.8, 54.3 and 53.5 per cent respectively. It should also be noted that the favourable values of the SPM were in part due to the fact that because of selection the *Gülbaba* and *Kisvárdai Rózsa* varieties were not evaluated and when using other methods (GM, IGM, DM) these spoiled the average. When using the German method PVY was reduced by 74.8 per cent and reductions of 33.3, 54.6 and 36 per cent were noted in case of the GM, IGM and DM respectively. Due to the GM, PVS reduced by 20.5 per cent. In any case the value of reduction was low (IGM = 12.1 per cent, DM = 13 per cent, SPM = 1.2 per cent). During the DM, PLRV was reduced by 78.6 per cent and 61.3 per cent and 67.6 per cent for the GM and IGM respectively. PLRV showed a low reduction value (14 per cent) in case of the summer planting method.

If we compare the results of the effects of individual agrotechnical methods to that of the control we gain the following results.

In case of the Dutch method PVX, PVY and PLRV were reduced by 9.1, 57.6 and 67.6 per cent respectively. For PVS, however, it was 0.8 per cent higher.

During the study of the SPM we discovered that in comparison to the control the occurrence of certain viruses was always higher (PVX = 62.2, PVY = 29, PVS = 12.5 and PLRV = 14 per cent).

The study of the yields revealed that in case of DM the average yield per plant of the individual varieties was 30.3 dkg lower than that of the basic stock. The average yield per variety was 4.1, 16.1 and 5 dkg higher in case of the GM, IGM and SPM respectively.

In comparison to the control the GM and IGM methods gave yields 7.1 and 4.8 dkg higher respectively. The SPM, however, showed a 6.3 dkg reduction in the average yield per variety. In this case it does not mean a serious drop, but if we separately examine the varieties it can be determined that there was a yield reduction per plant of 25, 9 and 18 dkg for the *Somogyi*

Kifli, *Gülbaba* and *Somogyi Korai* varieties respectively. This means an average reduction of 17.3 dkg in the yields of the three early-ripening varieties.

The results of resuming the few factors playing a role in the study of the methods show that an essential improvement in the health and quality of our seed potatoes occurs only in case we improve resistance, and judge more strictly the individual degrees of quality, if we try to eliminate the virus-sensitive varieties, extend objective identification, introduce further effective agrotechnical methods and if we try to evolve more fruitful methods of protection.

In addition we should pay increasing attention to other virus types (potato virus A, potato virus M, potato virus S, potato aucuba mosaic virus, potato bouquet virus, potato spindle tuber virus, potato stem mottle virus, potato stolbur virus (parastolbur, metastolbur), aster yellow virus, potato witches'broom virus, tomato spotted wilt virus, lucerne mosaic virus, cucumber mosaic virus, potato yellow-dwarf virus, potato leaf-rolling mosaic virus, potato corky ringspot virus, tomato black ring virus, beet ringspot virus etc.) and put more stress on their identification in the future.

In the end more attention should be paid to the observations made by MAIERHOFER (1964) on the significance of closed (exclusive) seed-potato growing regions and on the importance of the application of known procedures concerning plant health.

Acknowledgement

Here let me express my thanks to the Ministry of Agriculture and to the Research Institute for Plant Protection for their financial support and also to the Agricultural College of Keszthely for allowing me to carry out my experiments there. Last but not least let me thank Mrs. M. Mizser for her whole-hearted technical assistance throughout the course of my experiments.

REFERENCES

APPEL, O. (1907): Die Blattrollkrankheit der Kartoffelpfianze. Biol. Reichsanstalt Land- u. Forstw. Berlin—Dahlem 1907, 42.

APPEL, O. (1952): Die Wirkung der Infektionsquellen und der Umwelteinflüsse auf die Erhaltungszucht der Kartoffel. Züchter, **22**, 161—163.

APPEL, O. (1953): Kartoffelspätpflanzung. Mitschurin-Zirkel, **2**, 285—288.

AVAKJAN, V. A. (Авакян, В. А.) (1963): Условия выращивания и семенные качества картофеля. Вест. С/х Науки, **10**, 38—46.

BARBIER, R. (1962): La plantation estivale de la pomme de terre. Agric., **169**, 423—437.

BARSY, S. (1950*a*): Kísérletek a burgonya nyári ültetésével (Experiments on the Summer Planting of Potatoes). Magyar Mezőgazdaság, **19**, 12.

BARSY, S. (1950*b*): Kísérletek a burgonya nyári ültetésével (Experiments on the Summer Planting of Potatoes). Kis. Gaz. Évkönyve, **1**, 172—178.

BARSY, S. (1954): Adatok nyári burgonyatermesztéshez (Data on the Summer Growing of Potatoes). Növénytermelés, **1—2**, 65—66.

*BERKNER, F. (1933): Die Anwelkmethode im Kartoffelbau in ökologischer Betrachtung. Landw. Jb., **78**, 791—831.

*BERKNER, F. (1939): Altes und Neues vom Kartoffelspätanbau. Dtsch. Landw. Pr., **66**, 233—234.

BEZPALÜJ, I. D. (Беспалый, И. Д.) (1963): О влиянии условий яровизации на урожай картофеля. Агробиология, **6**, 920—921.

BÉRES, J. (1960): Adatok a burgonya leromlásának okaihoz (Data on the Causes of Potato Degeneration). Agrokémia és Talajtan, **4**, 535—548.

BÉRES, J. (1963*a*): A burgonyaleromlással kapcsolatos kémhatás vizsgálatok a burgonya gyökerében és gyökérzónájában (Examination of the Chemical Reaction of Potato Degeneration in the Root and in the Root Zone). Agrokémia és Talajtan, **1**, 135—141.

BÉRES, J. (1963*b*): Kiküszöbölhető-e a káros talajállapot hatása a burgonya leromlásában? (Can the Effect of Unfavourable Soil Condition of Potato Degeneration be Eliminated?). Agrokémia és Talajtan, **1**, 157—166.

BÉRES, J. (1963*c*): A talajkémiai és biokémiai tényezők döntő szerepe a burgonya leromlásában (The Decisive Role of Soil Chemical and Biochemical Factors in Potato Degeneration). Agrokémia és Talajtan, *I*, 145—156.

BIERECKI, M.—GABRIEL, V. (1964): A burgonyavetőgumó termesztés agrotechnikájának néhány kérdése. A burgonya nemesítése és vetőgumótermesztése (A Few Questions of the Agrotechnics of Seed-Potato Growing. Potato Breeding and Seed-Potato Growing). Nemzetközi Mgi. Szemle, **1**, 51—60.

BLATTNY, C.—BRCÁK, J.—POZDENA J.—DLABOLA, J.—LIMBERK, J.—BOJNANSKY, V. (1954): Die Übertragung des Stolburvirus bei Tabak und Tomaten und seine virogeographischen Beziehungen. Phytopath. Z., **22**, 381—416.

BOJNANSKY, V. (1957): Prispevok k symptomatike stolburu u zemiakov (Beitrag zur Symptomatologie der Stolburkrankheit bei Kartoffel). Biologie, **6**, 449—456.

BORUS, J. (1965): Rügydugványok vizsgálata a vetőburgonya minősítése szolgálatában (Using the Examination of Tuber Index of Seed Potatoes for the Classification of Seed Potatoes). Növényvédelem, **3**, 11—18.

BORUS, J.—DOHY, J.—SZALAY-MARZSÓ, L. (1965): A burgonyán élő levéltetvek vizsgálata és a védekezési kísérletek (Study of the Potato Aphids and Experiments to Control Them). MTA Agrártud. Közl., *XXIV*, 107—124.

BŐHME, R. W. (1933): Vergleichende Untersuchungen mit Stämmen des "X" und des "Y"-Virus. Phytopath. Z., **6**, 517—524.

BUKASOV, S. M. (Букасов, С. М.) (1958): Методы борьбы с вырождением и вирусными болезнями картофеля. Изд-во МСХ, **14**, 1—14.

BROADBENT, L. (1955): The Effects of Dates of Planting and Harvesting Potato Crops on Virus-disease Incidence and Yield. Ann. Appl. Biol., **43**, 149.

BROADBENT, L.—GREGORY, P. H.—TINSLEY, T. W. (1952): The Influence of Planting Date and Manuring on the Incidence of Virus Diseases in Potato Crops. Ann. Appl. Biol., **39**, 509—524.

*COONS, G. H.—COTILA, J. E. (1923): Michigan Potato Diseases. Michigan Agr. Exp. Sta. Res. Bull., 125.

CESNOKOV, P. G. (Чесноков, П. Г.) (1961): Болезни вырождения картофеля в СССР и борьба с ними. Изд-во С/х Литер. Москва. 1—320.

DE JONG, W. H.—HOFSTRA, D.—LEENSTRA, T. (1952): De teelt van aardappelpootgoed als stoppalgewas. Landbouw. Tijd., **64**, 728—731.

DEMEL, J.—WENZL, H. (1953): Die Sortenfähigkeit der Kartoffel gegen Fadenkeimigkeit. Die Bodenkultur, **7**, 142—151.

DUBUFFET, C. (1954): Essais d'amélioration de la culture de la pomme de terre par plantations retardées. C. R. Acad. Agr. Fr., **40**, 84—88.

*FABIANI, L. (1954): Potate de some dalle "secondo culture" padane. Mondo Agricolo, **49**, 5.

FAWEROV, A. M.—IL'IN, V. F. (Фаверов, А. М.—Ильин, В. Ф.— и др.) (1961): Летние посадки картофеля. Сельсхозгиз. I—III.

FAWEROV, A. M.—KOTOV, A. (1955): Die Sommerpflanzung der Kartoffel. Bauernverlag, Berlin.

FAWOROV, ST. (1953): Die Erzeugung gesunden Kartoffelpflanzgutes nach den Erfahrungen in der Sowjetunion. Dtsch. Landw., **4**, 339—346.

FODOR, I.—BRETAN, I. *et al.* (1963): Producerea metarialului de plantare la cartof. Probl. Agric., **6**, 17—26.

FORGÓ, S. (1962): A burgonyaleromlás okai, és az erre vonatkozó nézetek (The Causes of Potato Degeneration and the Views on it). Manuscript.

FRŐHLICH, H.—HENKEL, A. (1957): Versuche zur Erzeugung von gesundem Kartoffelpflanzgut in einem Abbaugebiet. Mitschurin-Bewegung, **6**, 788—794.

GABRIEL, W. (1959): Badania wstepne nad korelacja pomiedzy iloscia mszyc a rozprzestrzenianiem sie chorob wirusowych ziemniaka. Rocz. Nauk Roln., **3**, 797—819.

GABRIEL, W. (1961): Znaczenie niecktórych gatunków mszyc w rozprze storzenianin chorob wirusowich ziemniaka. Roczn. Nauk. Roln., **3**, 463.

GABRIEL, W.—NUCKOWSKI, S.—WISLOCKA, M. (1964): Badamia nad mczycami na plantacjach ziemmiaka. Polske pismo entomol., **4**, 25—56.

*GEYER, H. (1939): Einfluss der Pflanzzeit auf Ertragsleistung und Nachbauwert. Mitt. Deutsch. Landw., **54**, 222—223.

*GILBERT, A. H. (1923): Correlation of Foliage Degeneration Diseases of the Fresh Potato with Variations of the Tuber and Sprout. J. Agric. Res., **25**, 255.

GOERLITZ, H. (1955*a*): Über den Einfluss verschiedener Anbaumethoden auf Ertrag und Pflanzgutwert der Kartoffel. Züchter, **25**, 351—363.

GOERLITZ, H. (1955*b*): Verschiedene Pflanzkartoffel-Anbaumethoden, ihre Entwicklung und praktische Bedeutung. Dtsch. Landwirtsch., **6**, 232—235.

GOLDIN, M.—ELISEEVA, Z. N. (Гольдин, М.—Елисеева, З. Н.) (1961): Вирусные заболевания картофеля. Вест. АН Казах. ССР, **1**, 95—97.

GRAM, E. (1923): Einfluss des Anbauortes auf die Blattrollkrankheit der Kartoffel. Angew. Bot., **5**, 1—20.

GYIRES, GY. (1954): Nyári ültetéssel termeljünk egészséges vetőburgonyát (Healthy Seed Potatoes Produced from Summer Plantings). Magyar Mezőgazdaság, **12**, 5.

HEINZE, K. (1939): Zur Biologie und Systematik der virusübertragenden Blattläuse. Mitt. Biol. Reichsanst. Land- u. Forstw., Berlin—Dahlem, **59**, 35—48.

HEY, A. (1938): Versuche zum Kartoffelspätanbau. Arb. Biol. Reichsanstalt für Land- und Forstw., Berlin—Dahlem, **22**, 259—270.

HEY, A.—RAMSON, A. (1955): Untersuchungen über die Beziehungen zwischen Standort, Pflanzzeit und Nachbauwert von Kartoffeln. NachrBl. Dtsch. PflSchDienst, **9**, 189—199.

HINFNER, K. (1956): Burgonyafajták cérnahajtásképződése az 1953—55 évi országos kísérlet ben (The Thread-like Sprout Formation of Potato Varieties in the 1953—55 National Experiments). Orsz. Fajtakisérleti Int. Kiadv. Mg. Kiadó, Budapest

HINFNER, K. (1960): A burgonyafajták és fajtajelöltek rezisztencia vizsgálatainak eredményei az 1957—59 évi országos és provokatív kísérletek alapján (Results of the Resistance Tests of Potato Species and Test Species on the Basis of the 1957—59 National and Provocative Experiments). Orsz. Fajtakísérleti Int. Kiadv. Mg. Kiadó, Budapest.

HINFNER, K. (1963): A burgonyafajták és fajtajelöltek rezisztencia vizsgálatának eredményei az 1960—1963 évi országos kísérletekben (Results of the Resistance Tests of Potato Species and Test Species on the Basis of the 1960—63 National and Provocative Experiments). Orsz. Fajtakísérleti Int. Kiadv. Mg. Kiadó, Budapest.

HLAVAC, J. (1958): A burgonya termesztése (Plant Growing). Mg. Kiadó, Budapest.

HORVÁTH, J. (1958*a*): A burgonya levélsodródás vírus (Potato Leaf-Roll Virus). M. Mezőgazdaság, **22**, 5—6.

HORVÁTH, J. (1958*b*): Az Igel-Lange módszer gyakorlati alkalmazásának jelentősége (The Significance of Practical Application of the Igel-Lange Method). Délnyugatdunántuli Mg. Kis. Int. Évkönyve, Keszthely, **1**, 180—186.

HORVÁTH, J. (1960): Burgonyavírusok meghatározásának újabb eredményei (Latest Results on the Determination of Potato Viruses). Növénytermelés, **3**, 263—268.

HORVÁTH, J. (1962*a*): A burgonyavírusok identifikálásának módszerei és eredményei (The Methods and Results of the Identification of Potato Viruses). Diss., Keszthely, 1962.

HORVÁTH, J. (1962*b*): A burgonya vírusbetegségei és az ellenük való védekezés módszerei (Virus Diseases of Potato and Methods of Controlling Them). Növényvéd. időszerű kérdései, **3**, 63—69.

HORVÁTH, J. (1962*c*): A levélsodródás vírus (Corium solani Holmes) kimutatására alkalmazott Igel-Lange módszer megbízhatósága [The Reliability of the Igel-Lange Method for Demonstrating Leaf-roll Virus (Corium solani Holmes)]. Növénytermelés, **3**, 257—266.

HORVÁTH, J. (1963*a*): Neuere Beiträge zum Vorkommen von Kartoffelviren mit besonderer Rücksicht auf die Komplexinfektionen. Acta Agr. Acad. Sci. Hung., **13**, 67—81.

HORVÁTH, J. (1963*b*): A burgonya X-virus (Solanum virus 1, Smith) patofiziológiai diagnózisa [The Pathophysiological Diagnosis of Potato Virus X (Solanum virus 1, Smith)]. Növénytermelés, **3**, 265—270.

HORVÁTH, J. (1964): Ergebnisse der Identifizierung von mechanisch übertragbaren Kartoffelviren an Testpflanzen, mit besonderer Rücksicht auf Vergleichsuntersuchungen. Acta Agr. Acad. Sci. Hung., **14**, 103—134.

HORVÁTH, J. (1966*a*): Studies on Strains of Potato Virus Y. 1. Strain C. Acta Phytopath. Acad. Sci. Hung., **1**, 125—138.
HORVÁTH, J. (1966*b*): Studies on Strains of Potato Virus Y. 2. Normal strains. Acta Phytopath. Acad. Sci. Hung., **1**, 333—352.
HORVÁTH, J. (1966*c*): Data on the Possibilities of Controlling Potato Virus. I. General Survey of the Methods of Control and the Virus Infection of Experimental Potato Varieties. Acta Agr. Sci. Hung., **15**, 177—186.
HORVÁTH, J. (1966*d*): Data on the Possibilities of Controlling Potato Virus. II. Experiments with the German Method and the Improved German Method. Acta Agr. Acad. Sci. Hung., **15**, 381—393.
HORVÁTH, J. (1966*e*): Data on the Possibilities of Controlling Potato Virus. III. Examinations with the Dutch Method. Acta Agr. Acad. Sci. Hung., **16**, 75—86.
HORVÁTH, J. (1967*a*): Studies on Strains of Potato Virus Y. 3. Strain Causing Browning of Midribs in Tobacco. Acta Phytopath. Acad. Sci. Hung., **2**, 95—108.
HORVÁTH, J. (1967*b*): Studies on Strains of Potato Virus Y. 4. Anomalous Strain. Acta Phytopath. Acad. Sci. Hung., **2**, 195—210.
HORVÁTH, J.—SOLYMOSY, F. (1962): Tesztnövények alkalmazásának jelentősége a burgonya vírusbetegségeinek kimutatásában (The Significance of the Application of Test Plants in Demonstrating the Virus Diseases of Potatoes). Növénytermelés, **4**, 369—376.
HORVÁTH, J.—HINFNER, K. (1964): Adatok a burgonya K-virus (Solanum virus 11, Smith) magyarországi előfordulásához [Data on the Occurrence of Potato Virus K in Hungary (Solanum virus 11, Smith)]. Növénytermelés, **1**, 83—86.
JERMOLJEV, E.—PRUSA, V. (1961): Studium vlivu chologickych ciniteln a vyrovich chorob na produktivitu sadby a fiziologii bramborovich rostlin. Sborn. CSAZV. Rost. vyroba, **10**, 1351—1366.
KIRÁLY, Z. (1950*a*): Liszenko magyarázata a burgonya leromlásáról (Lysenko's Explanation of Potato Degeneration). Magyar Mezőgazdaság, **12**, 21.
KIRÁLY, Z. (1950*b*): A burgonya leromlása (The Degeneration of Potatoes). Élet és Tudomány, **36**, 305—307.
KLINKOWSKI, M. (1958): Beiträge zur Kenntnis der Stolburkrankheit der Kartoffel. Proc. 3rd Conf. Pot. Vir. Dis. Lisse—Wageningen 1957, 264—277.
KLINKOWSKI, M.—KEGLER, H. (1962): Viruskrankheiten der Kartoffel. In: SCHICH, R.—KLINKOWSKI, M.: Die Kartoffel, *II*, 1025—1133.
KOLTAY, M. (1953): A nyári ültetésű burgonya termelése (The Growth of Summer-Planted Potatoes). Magyar Mezőgazdaság, **12**, 15.
KOTOV, A. (Котов, А.) (1964): Ускоренное размножение клубней. Картофель и овощи. Москва, **2**, 6—8.
KOVACHEWSKY, I. (1954): Die Stolburkrankheit der Solanaceean. NachrBl.Dtsch.PflSchutz-Dienst, **8**, 161—166.
KOVACHEWSKY, I. (1964): Untersuchungen über die Stolburkrankheit in Bulgarien. Verlag der Bulg. Akad. Wiss. Sofia, 1964.
KÖHLER, E. (1934): Untersuchungen über die Viruskrankheiten der Kartoffel. Weitere Versuche mit Viren aus der Mosaikgruppe. Phytopath. Z., **7**, 1—30.
KÖHLER, E. (1936): Studien über den Verlauf des Kartoffelabbaues auf dem Dahlemer Versuchsfeld der Biologischen Zentralanstalt. Landw. Jb., **83**, 858—868.
KÖNNECKE, G. (1951): Die Sommerpflanzung der Kartoffeln. Dtsch. Landw., **2**, 249—252.
KRIVECKIY, P. S. (Крывецкий, П. С.) (1960): Про насинни якости элиты картопло, яку вырощийту разных зонах Укр.ССР. Висн. Сильс. хосп. Науки. **11**, 52—57.
LABOUNEK, V. (1963): Ochabováni bramborové sadby v suché oblasti Jizni Moravy. Sbor. Vys. Skoly Zemed. Rada A Spisy Fytotechn. Zootechn. Ekon., **4**, 450—459.
LÁZÁR, V.—BOLTIZÁR, M. (1950): Nyári ültetésű burgonyakísérletek eredményei Gödöllőn (Results of the Summer Planting of Potatoes at Gödöllő). Agrártudomány, **7**, 241—242.
LINNIK, G. N. (Линник, Г. Н.) (1955): О причинах вырождения картофеля. Критика экологической и вирусной теории, Ботанический Журнал. **4**, 528—541.
LYSENKO, T. D. (Лысенко, Т. Д.) (1949): Агробиология. Сельхозгиз. Москва.
LYSENKO, T. D. (Лысенко, Т. Д.) (1953): Избранные сочинения. Изд-во «Московский Рабочий». Москва.
LÜDDECKE, F. (1956): Bericht über die Ergebnisse der anbautechnischen Feldversuche zur Kartoffelpflanzguterzeugung aus den Jahren 1954 und 1955. Z. landw. Vers.- u. Unters. Wesen, **2**, 388—399.
LÜDDECKE, F. (1957): Massnahmen zur Steigerung der Kartoffelerträge. Dtsch. Landw., **8**, 58—63.

MAIERHOFFER, E. (1963): Zur Frage der Blattlausbekämpfung auf Pflanzkartoffelbeständen in Oberösterreich. Die Bodenkultur, **1**, 68—79.

MAIERHOFFER, E. (1964): Massnahmen zur Bekämpfung der Virusausbreitung im Pflanzenkartoffelbau. Ein Überblick. Die Bodenkultur, **4**, 340—349.

MARX, TH.—MERKENSCHLAGER, F. (1932): Zur Biologie der Kartoffel. XXII. Mitt. Beobachtungen und Untersuchungen über den Verlauf des Kartoffelabbaues. Arb. Biol. Reichsanst. Berlin—Dahlem, **19**, 413—493.

*MUNCIE, J. H. (1943): Michigan Potato Diseases and their Control. Extension Bull., 162.

MÜNSTER, J. (1954): La valeur de la plantation tardive des pommes de terre pour la production du plant. Rev. Rom. Agr., **10**, 79—81.

NEMCSIN, F. I. (Немчин, Ф. И.) (1963): Сохранение от вырождения и повышение продуктивности картофеля в южных районах. Вест. С/х Науки. **3**, 138—139.

NESTERENKO, V. (Нестеренко, В.) (1964): Как повысить урожайность картофеля на юге. Колх-совх. произв. Молдавии. Кишинев. **4**, 36—37.

NURMISTE, B. H. (Нурмисте, В. Н.) (1958): Оценка методов борьбы с вырождением картофеля. Изд-во МСХ. **12**, 3—12.

NYÉKI, J. (1960): Adatok a különböző termőhelyeken termelt vetőburgonyák biológiai értékének alakulásához (Data on the Formation of the Biological Value of Seed Potatoes Grown at Various Sites). Növénytermelés, **1**, 73—78.

OPITZ, K. (1940): Weitere Versuche über den durch Viruskrankheiten herbeigeführten Abbau der Kartoffel. Pflanzenbau, **16**, 323—342.

*ORTON, W. A. (1914): Potato Wilt, Leaf Roll and Related Diseases. U. S. Dept. Agr. Res. Bull., 64.

PETRÓCZI, I. (1962): Sztolbur és sztolburhoz hasonló megbetegedések nyugatmagyarországi burgonyatermesztő vidékeinken (Stolbur and Similar Diseases in the Potato Growing Areas of Western Hungary). Növénytermelés, **2**, 183—189.

PONOMARENKO, P. V. (Пономаренко, П. В.) (1962): Вплыв строкив литного садиння на насинни якости картопли в умавах пивнихного степу Украйны. Вис. Сельск. Госп. Науки. **6**, 62—67.

POZDENA, J.—POLYÁK, Z.—BLATTNY, C. (1954): The Influence of Summer Planting of Potato Infected with Virus Diseases on the Improvement of its State of Health. Soc. Agr. Sci. Ser. A., **3**, 160—169.

PROFFT, J. (1940): Über das Auftreten von Viren und virusübertragenden Blattläusen in zeitlich gestaffelten Kartoffelpflanzungen Ostpommerns. Landw. Jb., **89**, 922—935.

*QUANJER, H. M.—DORST, J. C. — DIJT, M. D. — VAN DER HÁAR, A. W. (1919): De mozaikziekte van de Solanaceen, hare verwantschap met de phloemnecroseen haare bebeeknis voor de aardappelcultuur. Meded. Landb., **17**, 1—90.

RAMSON A. (1959): Untersuchungen über die Beziehungen zwischen Witterung und Nachbauwert der Kartoffeln. NachrBl. Dtsch. PflschDienst, **13**, 46—55.

RÉDEI, GY. (1951*a*): A burgonya nyári ültetésének időszerű kérdései (Timely Questions on the Summer Planting of Potatoes.) M. Mezőgazdaság, **12—13**, 14.

RÉDEI, GY. (1951*b*): A burgonya nyári ültetése (Summer Planting of Potatoes). Mg. Kiadó, Budapest.

RÉTHY, B. (1964): Holland módszerrel végzett vetőburgonyatermesztés fejlesztési lehetőségeinek vizsgálata Dunántúlon (Analysis of the Possibilities of Developing Seed-Potato Growing with the Dutch Method in Transdanubia). Diss. Gödöllő.

ROZALIN, L. V. (Рожалин, Л. В.) (1960): Агротехника семенного картофеля. Селекция и семеноводство картофеля. Изд-во МСХ СССР. 74—77.

ROZALIN, L. V.—FILIPPOV, D. J.—BELOVA, O. D. (Рожалин, Л. В.—Филиппов, Д. Я.—Белова, О. Д.) (1959): Новое в улучшении семенных качеств картофеля. Сельхозгиз. 343—355.

RUDENKO, A. J. (Руденко, А. Я.) (1960): Меры борьбы с климатическим типом вырождения картофеля. Селекция и семеноводство картофеля. Изд-во МСХ. 109—123.

SÁRVÁRI, I. (1960): A burgonyaleromlás elleni védekezési munkák főbb eredményei (Main Results of the Control Work against Potato Degeneration). Duna-Tiszaközi Mg. Kis. Int. Évk., Kecskemét, 1960.

SCHICK, R. (1952): Fragen der Pflanzkartoffelerzeugung. Dtsch. Landw., **3**, 618—627.

SCHLEUSENER, W. (1953): Pflanzkartoffelbau. Bauernverlag, Berlin.

SCHLEUSENER, W.—GOERLITZ, H. (1952): Über den Einfluss verschiedener Anbaumethoden auf Ertrag und Pflanzgutwert der Kartoffel. I. Bericht: Ernte 1950/61. Züchter, **22**, 127—134.

SCHMELZER, K.—LEHMANN, W.—NAUMANN, K. (1963): Pflanzenschutz im Kartoffelbau. Ges. Verbreitung Wiss. Kenntnisse, Halle (Saale) 1—64.

SCHREIER, O. (1953): Über das Auftreten von Blattläusen an Kartoffelstauden in Niederösterreich im Jahre 1952. Pflanzenschutz Ber., **10**, 129—153.
*SCHULTZ, E. S.—FOLSOM, D. (1925): Infection and Dissemination Experiments with Degeneration Diseases of Potatoes. J. Agr. Res., **30**, 493—528.
SCHWEIGER, W. (1962): Pflanzguterzeugung. In: SCHICK, R.—KLINKOWSKI, M.: Die Kartoffel. II. 1565—1673.
SESSOUS, G.—PIELEN, L. (1942): Versuche zur Einschränkung des durch Viruskrankheiten hervorgerufenen Abbaus der Kartoffel durch anbautechnische Massnahmen. Landw. Jb., **89**, 32—58.
SIMON, J. (1939): Kartoffelsommerkultur als ein Mittel gegen den Abbau der Kartoffel. XVIII. Internat. Landw. Kongr. Dresden.
SLOMNICKI, I. (1961): Potato Growing Two Seasons a Year from Local Seeds in Israel. Proc. 15th Intern. Hort. Congr. Nice, Pergamon Press, London. **1**, 476—481.
SOLYMOSY, F. (1957): A növényi víruskutatás ujabb irányai és eredményei (Latest Directions and Results in Plant Virus Research). Témadokumentáció, OMgK, Budapest.
SOLYMOSY, F. (1962): A burgonya vírusos leromlása elleni védekezés (Control against the Virus Degeneration of Potatoes). Mg. Világirodalom, **2**, 13—19.
SOMORJAI, F.—BÉRCZI, L.—POSGAY, E. (1952): 1951 évi nyári ültetésű burgonyatermesztési kísérletek Szegeden, (The 1951 Experiments with the Summer Planting of Potatoes in Szeged). Növénytermelés, **1**, 111—122.
SOMORJAI, F. (1954): A burgonya nyári ültetésének jelentősége (Significance of the Summer Planting of Potatoes). Agrártudomány, **7**, 196—198.
SOMOS, A. (1952): A magyar növénynemesítés a Micsurin-Liszenko biológiában (A burgonyaleromlás megállapításáról). (Hungarian Plant Breeding in the Michurin-Lysenko Biology/ On Determining Potato Degenerations). Élet és Tudomány, **15**, 456—457.
STEINECK, O. (1955): Neue Ansichten über den Kartoffelbau. Der Förderungsdienst, **3**, 79—81.
SZABÓ, I. (1952): A vetőburgonya jarovizálása nyári ültetéshez (Vernalization of Seed Potatoes for Summer Planting). Magyar Mezőgazd., **9—10**, 7.
SZALAI, J.—LUSZTIG, G. (1954): A burgonya fejlődése tavaszi és mesterségesen hajtatott újgumók nyári ültetése esetében (Potato Development in Case of Spring and Artificially Forced New Seeds Planted in Summer). Növénytermelés, **1—2**, 11—18.
SZIRMAI, J. (1939): Die Abbaukrankheiten bei den Kulturpflanzen besonders bei der Kartoffel. XVIII. Internat. Landw. Kongr. Dresden.
SZIRMAI, J. (1947): A burgonya vírusos hajtásszáradása (The Drying of Potato Sprouts due to Virus). Magyar Mezőgazdaság, **1**, 10.
SZIRMAI, J. (1950): Kísérletek egészséges vetőmag nyerésére vírusbeteg növényekből (Experiments in Obtaining a Healthy Seed From Virus Infected Plants). Ann. Inst. Prot. Plant. Hung., **5**, 215—227.
SZIRMAI, J. (1953): A burgonya leromlásának ökológiai és vírusos tényezői (The Ecological and Virological Factors of the Potato Degeneration). Ann. Inst. Prot. Plant. Hung., **6**, 238—255.
SZIRMAI, J. (1954): Túlérzékenységi reakció felhasználása a burgonya X-vírus elleni nemesítésében (Employing the Hypersensitive Reaction when Improving against Potato Virus X). Növénytermelés, **3**, 209—214.
SZIRMAI, J. (1956): Új vírusbetegség hazánkban (New Virus Diseases in Hungary). Agrártudomány, **8**, 351—353.
SZIRMAI, J. (1958*a*): Stolbur virus in Ungarn. Stolbur a pribuzné virusové bezsemenosti rastlin. Slov. Acad. Sci. Bratislava 109—118.
SZIRMAI, J. (1958*b*): A burgonya Y-vírusának érbarnulást okozó változata a dohánykultúrákban (The Vein-browning Strain of Potato Virus Y in Tobacco Cultures). Növénytermelés, **7**, 341—350.
SZIRMAI, J. (1959): A burgonya gombás és vírusbetegségei és az ellenük való védekezés (Fungus and Virus Diseases of Potato and their Control). MTA Agrártud. O. Közl., **15**, 1—3.
SZIRMAI, J. (1960): Prüfung des Kartoffelabbaus durch Testen mit Serum-Knollenröhrchen auf Grund der Polyphenoloxydase-Aktivität. Acta Agr. Acad. Sci. Hung., **3—4**, 443—454.
SZIRMAI, J. (1963): Zusammenhang zwischen dem Kartoffelbau und der Polyphenoloxydase-Aktivität. Z. Bakt. Hygiene, II. Abt., **116**, 240—245.
SOKOLENKO, N. F. (Соколенко, Н. Ф.) (1963): Улучшение семенных качеств картофеля путем летних посадок. Изд-во АН СССР, 523—528.
SOKOL, P.—KOLESNIK, A. (Сокол, П.—Колесник, А.) (1963): Хранение клубней летних посадок. Картофель и овощи, **5**, 12—13.
SZTAJKOV, G. D. (1964): Vlijanie na szrokovete na zaszazsdane vörhu rasztezsa, razvitieto,

dobiva i kacsesztvoto na kartofite kato poszadöcsen material. Naucsni Trudove, Plovdiv, **1**, 69—85.

SUHOV, K. S. (Сухов, К. С.) (1956): О мерах борьбы с вирусными заболеваниями растений. Вирусы. Москва. Изд-во АН СССР. 329—334.

TAMÁSSY, I.—BARNA, B. (1963): A burgonya nyári ültetéséből eredő utóhatás vizsgálata (Study of the Post-effects of the Summer Planting of Potatoes). Kert. és Szőlészeti Főisk. Évk., Budapest.

TEICHMANN, V. (1959): A hazai burgonyatermesztés és nemesítés helyzete és feladataink (The Situation and Tasks of Potato Growing and Breeding in Hungary). MTA Agrártud. O. Közl., **1—3**, 9—111.

TIZIO, R. (1962) La dégénérescence de la pomme de terre: effect de la haute température et du virus X sur la variété Bintje. Fiton, **2**, 137—150.

ULRICH, G.—NEITZEL, K.—SCHOLZ, M. (1963): Untersuchungen zum Kartoffelabbau unter trockenen und warmen Anbaubedingungen der Südukraine. Eur. Pot. J., **4**, 227—241.

VALENTA, V. (1959): Zwei bisher unbekannte Kartoffelwelke verursachende Viren aus Mitteleuropa. Phytopath. Z., **39**, 271—276.

VOLKOV, V. (Волков, В.) (1963); Изыскиваем простейшие способы выращивания элиты. Картофель и овощи, **7**, 12—13.

WARTENBERG, H. (1937): Probleme der Forschungen über den Abbau der Kartoffel. Züchter, **9**, 35—40.

WARTENBERG, H. (1954): Erfahrungen mit Spätpflanzungen (Sommerpflanzungen) und Früh-ernten (Krautziehen) zur Gewinnung gesunder Pflanzkartoffeln. Dtsch. Landw., **5**, 578—581.

WARTENBERG, H.—KLINKOWSKI, M.—HEY, A (1935): Der Tagesparzellenversuch. Angew. Bot., **17**, 74—94.

WATSON, M. A.—ROBERTS, F. M. (1939): A Comparative Study of the Transmission of Hyoscyamus Virus 3, Potato Virus Y and Cucumber Virus 1 by the Vectors Myzus persicae (Sulz.), M.-circumflexus (Buckton), and Macrosiphon gei (Koch). Proc. Roy. Soc. Ser. B, **127**, 543—576.

WENZL, H. (1950): Zur Frage des nichtvirösen Kartoffelabbaues. Die Bodenkultur, **2**, 152—160.

WENZL, H. (1953): Untersuchungen über den nichtvirösen Kartoffelabbau. Z. Pflkrankh., **60**, 65—77.

WENZL, H. (1955): Sommeranbau als Massnahme gegen Abbau durch knollenübertragbare Kartoffelviren und gegen Fadenkeimigkeitsabbau. Die Bodenkultur, **3**, 274—306.

WENZL, H. (1956*a*): Die Diagnose der Fadenkeimigkeit an ungekeimten Kartoffelknollen mittels der Kallose-Reaktion. Pflanzenschutz Ber., **1—3**, 21—35.

WENZL, H. (1956*b*): Die Stolbur-Virose in Österreich. Pflanzenschutz Ber., **10—12**, 159—162.

WENZL, H. (1963): Kritik der Theorie der ökologischen Verursachung der Kartoffelwelke (Gummiknollenwelke). Pflanzenschutz Ber., **11—12**, 173—182.

WENZL, H. (1964): Die Welkekrankheit der Kartoffel. Pflanzenschutz Ber., **11—12**, 161—178.

WENZL, H. (1965*a*): Fadenkeimigkeit als Begleiterscheinung von Blattroll der Kartoffel. Pflanzenschutz Ber., **9—10**, 147—154.

WENZL, H. (1965*b*): Personal communication.

WENZL, H.—DEMEL, J. (1952): Untersuchungen über den Pflanzgutwert fadenkeimiger Kartoffeln. Die Bodenkultur, **6**, 41—54.

WENZL, H.—GLASER, G. (1959): Untersuchungen über den histologischen Nachweis von Fadenkeimigkeit und Blattroll in Kartoffelknollen. Pflanzenschutz Ber., **22**, 1—30.

ZADINA, J.—VOTUPAL, B. (1953): Vysledky pokusu s lenim bramboru pro zcskáni zdravé sadby. Sborn. Ceskoslov. Acad. Zem. Ser. A., **26**, 175—186.

ZHUKOVA, G.—PISAREV, V. (Жукова, Г.—Писарев, В.) (1964): Лучшие сроки и способы посадки картофеля. Картофель и овощи, **4**, 2—5.

* Originals not seen.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 131—138 (1968)

DEVELOPMENTAL PHYSIOLOGICAL PROBLEMS OF THE PRODUCTION OF HIGH-YIELDING, WINTER-HARDY WHEAT VARIETIES HAVING A SHORT GROWING SEASON

By

L. BALLA

AGRICULTURAL RESEARCH INSTITUTE OF THE HUNGARIAN ACADEMY OF SCIENCES, MARTONVÁSÁR

The development of many Hungarian, West European and Soviet wheat varieties and their hybrids have been examined under different day lengths. Part of the Hungarian and West European varieties and the *Mironovskaya 808* have strongly reacted to short day. *San Pastore, Skorospelka 3b* have hardly showed any reaction while the *Bezostaya 1* and *Etoile de Choisy* can be placed between the two groups. The resultant hybrids have reacted to day length similarly to the less sensitive parent.

Introduction

In Hungary wheat breeders try to produce wheat varieties characterized by winter-hardiness, great productivity and a short growing season. In order to realize these goals such crossing partners are necessary as are outstanding in respect to these properties. Among the Hungarian varieties we find winter-hardy and early crossing partners, but there are none that can be used for the breeding of a very productive intensive variety. According to our present knowledge such a variety can be obtained from two sources. One is the Italian varieties and the other the group of West European varieties. If we use the Italian varieties for breeding, then what faces us is the winter-hardiness and if we use the West European ones both winter-hardiness and growing season must be reckoned with.

Bearing in mind the continental climate of Hungary with its cold winters and extremely dry summers we cannot comprise for either winter-hardiness or growing period. Only those varieties may be considered for our purpose that are excellently winter-hard during Hungarian winters and will have ripened the latest at the end of June or the beginning of July (before the height of summer and the droughts) and that give a large yield. The union of these three properties makes the solution to many developmental physiological and genetical questions a must. Among others it is necessary to determine the photoperiodic requirements of the varieties, the necessary temperature and day length for the start of early spring development and the relation of these two factors to winter-hardiness and productivity of the varieties. Moreover, we have to clarify which crossing partners necessary for the formation of great productivity are the most appropriate in terms of developmental physiological properties and how these mentioned properties can be combined in the hybrids. During our research we studied these questions.

Although the role of day length in the life of plants had already been stressed at the beginning of the century by KLEBS (1918), GARNER—ALLARD (1920), few researchers have treated the problems related to the significance of day length, its effects on the growth of wheat and especially the relation between productivity, winter-hardiness and the phases of development. RUDORF (1939) has pointed out the importance of the photoperiod in breeding. He was the first to note the close relation of cold resistance to vernalization requirement but especially to the length of the day. The evaluation of the role of photoperiod was greatly aided by LYSENKO (1948) who formulated the theory of the phasic development of plants. Afterwards many authors began studying the developmental physiological role of day length. RIMPAU (1958) studied the interrelation of cold resistance and the "critical day length". He determined the critical day length of varieties originating from a few different zones among laboratory conditions. SCHMALZ (1953) examined the effect of various day lengths on the development of different varieties included in the world's genetic stocks. Both discovered that the minimum day length for wheat was between 10 and 16 hours. During his investigations SCHMALZ discovered the great extent to which development proceeded faster by the lengthening of the day cycle. He discovered that the speed of development was conversely related to the number of tillers and to the number of grains per spike.

CLAVER—SIVORI (1950) discovered that generative growth started among wheats requiring a longer day cycle although their development proceeded slowly. They also observed that the very early *Klein 31* variety — in contrast to the *Lin Calel* and *Kanhard* varieties — blossomed sooner in a natural day cycle than on 24-hour photoperiod.

GRIES *et al.* (1956) examined four wheat varieties in an air-conditioned climatic chamber and they discovered that the Chinese variety had made the best use of the light on 8-hour photoperiod while the Federation and Progress varieties on 16-hour photoperiod. The high temperature and the 24-hour photoperiod slowed down the growth of the Chinese variety unlike that of the other varieties.

FEEKES (1941) has made experiments with sowing at different times trying to discover the relation of day length and temperature changes to yield components. It was discovered that day length and temperature not only affected the time of shooting but also the number of tillers and the weight of grains. HANSEL (1955) in his experiments with sowing at different times has revealed the developmental relations of a large number of wheat varieties thus offering a good starting point for the description of the wheat varieties according to developmental physiology.

WIENHUES (1961) has studied day length and temperature requirements of many wheat varieties as factors of earliness and productivity. He has discovered that the varieties can be divided into different groups according to the photoperiods required, that the growth inhibiting effect of short day is manifest mostly in the 6th—10th stages of the Bonnet scale of development. This corresponds to the photostages of phasic development discovered by LYSENKO.

We possess no data on the day length reaction of Hungarian varieties or of hybrids resulting from crosses between short and long day-cycle varieties on the productivity, winter-hardiness and vegetation period of the forms which can be bred.

Material and Methods

Our examinations took place in Martonvásár between 1960 and 1965. We studied the reaction of the varieties and hybrids to day length in a special experiment. The seeds were vernalized and when the temperature was appropriate for the development of all wheat varieties they were planted. This generally took place between April 15—20. We employed three photoperiods: 10-, 12-hour and normal. The first two correspond to the day length from between the middle of February to March 21st in Hungary. The normal day length was 14—15 hours.

Shortened day was assured by covering the plots. During the first years we provided for the appropriate ventilation and exchange of air of the wheat under the covers by such an opening as blocked light; later we attached an exhauster which constantly sucked out the stale air from under the cover.

We have indicated the photoperiodic sensitivity of wheat with the time of heading and the heading dynamics. In order to determine this we have counted the headed individuals every five day. The counting continued for 30 days from the beginning of the first heading.

In the spring of 1966 it was possible to control our experiment under natural conditions too, since the February temperature allowed development to start even during the short day. We have determined three stages for the intensity of spring development: quick, medium and slow. When studying the pace of development we took into consideration the autumn growth type as well.

The examined varieties are produced in the different geographical and climatic zones of Europe. Their growing periods and types are different. On breeding the hybrids we have selected the partners for crossing so that the combinations could be divided into two groups. The first is light-requiring × indifferent, the second indifferent to light × indifferent. Within the groups we have crossed varieties with different growing periods, and, thus, produced varied material for the examination. The varieties used in crossing were the following:

Bezostaya 1: Soviet variety, medium-late, erect type of autumn growth, quick early spring development.

Fertődi 293: Medium-late, prostrate type of autumn growth, slow early spring development.

H. 1444: Hybrid of German origin, late, prostrate type of autumn growth, slow early spring development.

Skorospelka 3b: Soviet variety, early, semierect type of autumn growth, quick early spring development.

Etoile de Choisy: French variety, medium ripening, erect type of autumn growth, medium-quick early spring development.

Produttore 6: Italian variety, medium-late, erect type of autumn growth, slow early spring development.

San Pastore: Italian variety, early, erect type of autumn growth, quick early spring development.

Results

The data gained have been represented on a graph: the vertical axis shows the percentage of heading and the horizontal the date of examination. As we can see from Fig. 1*a—c*, the Hungarian varieties and *Mironovskaya 808* are unusually sensitive to the short day. On the 12 and 10 hours of day

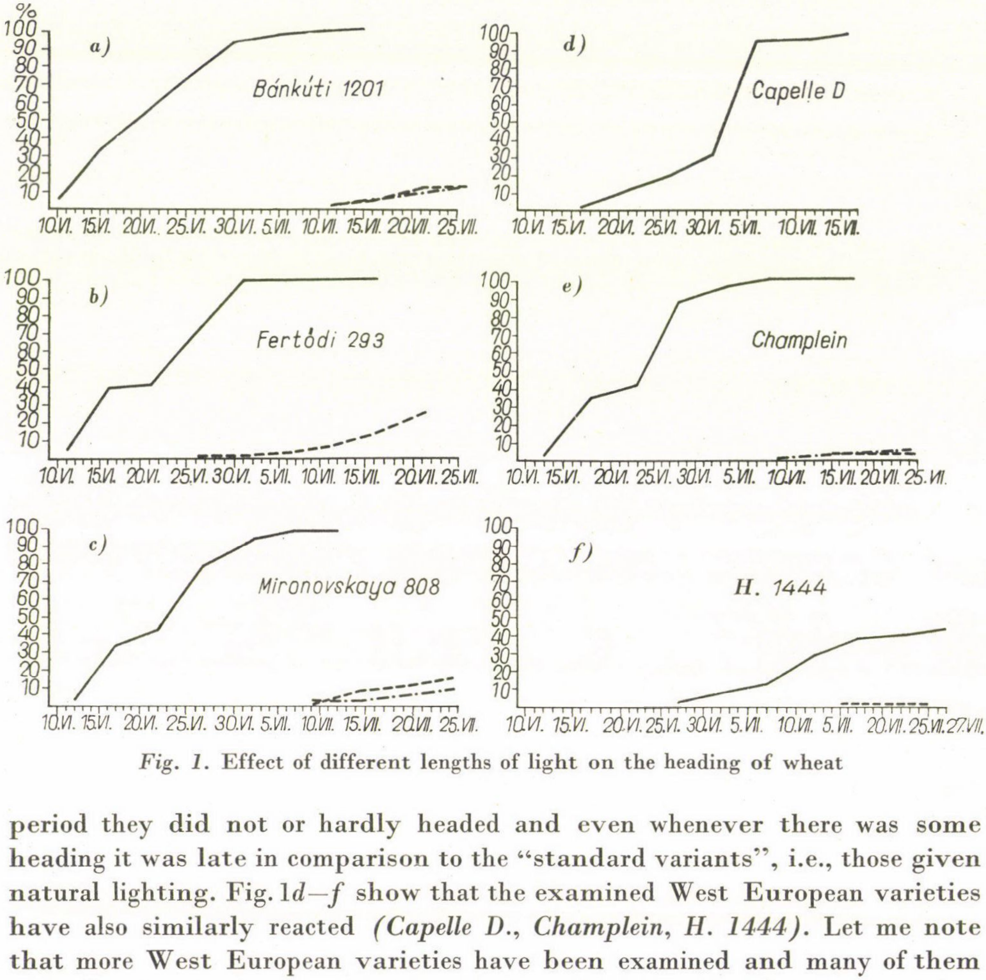


Fig. 1. Effect of different lengths of light on the heading of wheat

period they did not or hardly headed and even whenever there was some heading it was late in comparison to the "standard variants", i.e., those given natural lighting. Fig. 1*d—f* show that the examined West European varieties have also similarly reacted *(Capelle D., Champlein, H. 1444)*. Let me note that more West European varieties have been examined and many of them proved to be much more sensitive to short day than the above ones. A few of them slowly headed even when included among the "natural (standard) variants".

Fig. 2*a—b* show that the second group of varieties have not or hardly reacted to the short day. The treated variants began to head when the standard ones did and continued at the same or at a hardly different pace. The *San Pastore* and many Italian varieties as well as *Skorospelka 3b* belong to this group.

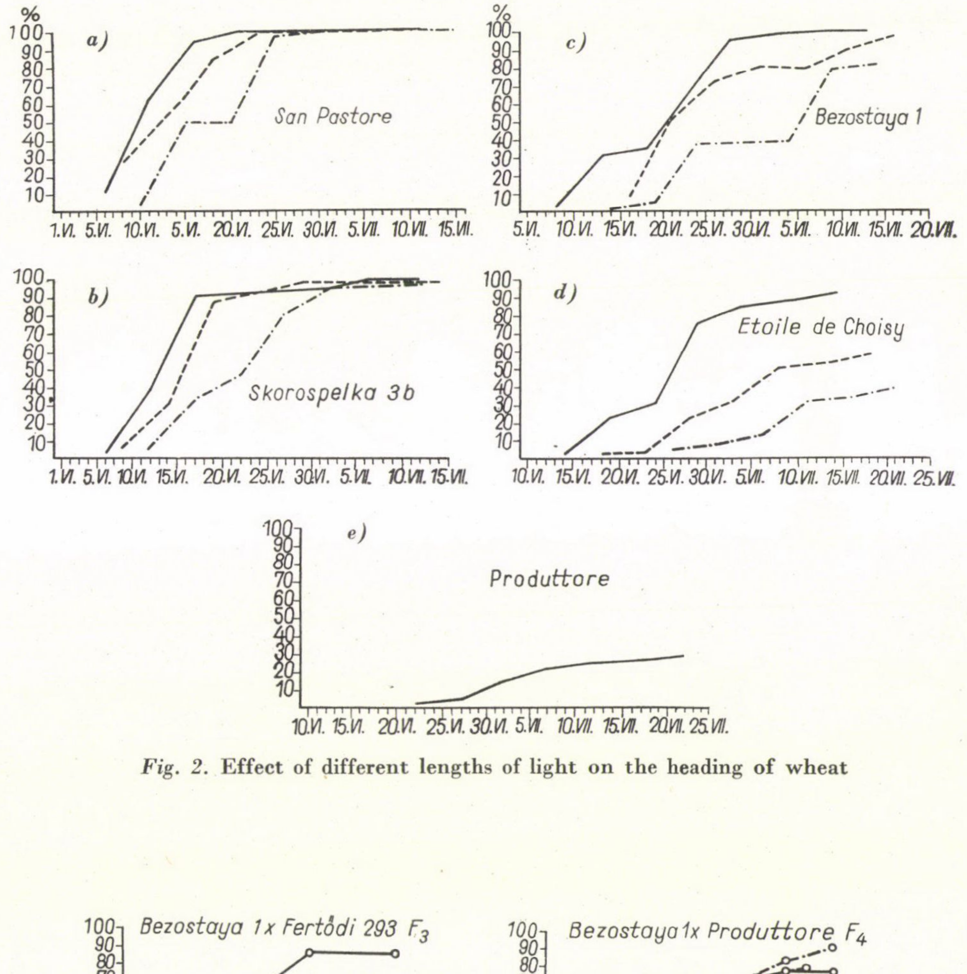


Fig. 2. Effect of different lengths of light on the heading of wheat

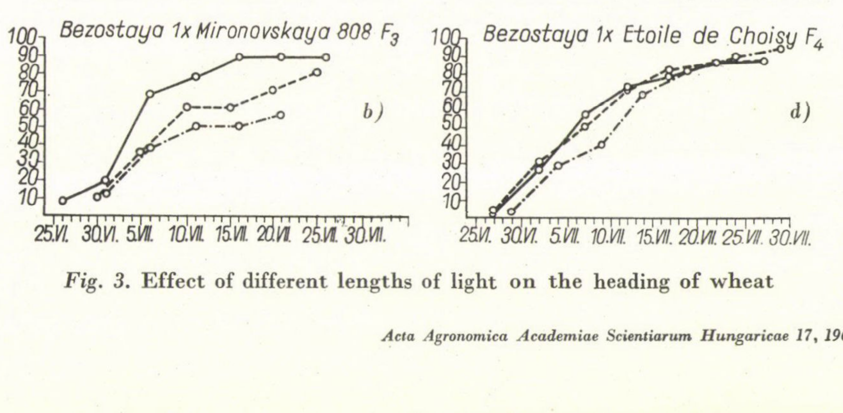


Fig. 3. Effect of different lengths of light on the heading of wheat

As it can be seen from Fig. 2*c*—*d* the Soviet *Bezostaya 1* and the French *Etoile de Choisy* have shown some reaction to both the start of heading and to the rate of heading. These, however, are by no means so sensitive as the Hungarian and West European varieties. The *Etoile de Choisy* can be considered intermediary between the two groups representing extreme values, while the *Bezostaya 1* is closer to the short-day bearing group. It is interesting to note that the *Produttore 6*, contrary to its southern European origin, behaves similarly to those of the West (Fig. 2*e*).

The results of the hybrid examination are given in Fig. 3*a*—*c*. As it can be seen, the light sensitivity of the *Bezostaya 1* × *Fertődi 293* F_3 hybrid population is very close to that of the *Bezostaya 1*. A similar light sensitivity is exhibited by the F_2 of the *Bezostaya 1* × *Mironovskaya 808* and by the F_4 of the *Bezostaya 1* × *Produttore 6*.

The hybrids of the second group in which both parents are indifferent or slightly sensitive to the short day is represented by the F_4 of *Bezostaya 1* × *Etoile de Choisy*. The results are shown in Fig. 3*d*. Just as the behaviour of the parents has led us to expect, the hybrids are not sensitive to the short day.

Table 1

Examination of early spring development and growth type (1966)

Name	No. of plants	Quick				Medium				Slow			
		Pro-strate	Semi-erect	Erect	Total	Pro-strate	Semi-erect	Erect	Total	Pro-strate	Semi-erect	Erect	Total
		%				%				%			
Bez. 1 × *F. 293* F_4	56	2	39	—	41	43	14	—	57	2	—	—	2
Bez. 1 × *H. 1444* F_4	60	—	8	—	8	30	35	—	65	27	—	—	27
Sk. × *H. 1444* F_4	37	3	3	—	6	24	32	—	56	35	3	—	38
Bez. 1 × *Etoile* F_5	32	—	25	16	41	—	40	19	59	—	—	—	—
Bez. 1 × *Prod. 6* F_5	34	—	3	10	13	—	27	45	72	—	3	12	15
Bez. 1 × *San P.* F_5	55	—	2	13	15	—	22	50	72	—	9	4	13

Afterwards the results of the photostage analyses were controlled in field test. In accordance with our method of breeding we have selected elite plants from the hybrid population in the F_3 and F_4 generations. The produce of individual plants has been set in comparative experiments and observed by the intensity of their early spring development. The results are given in Table 1. When taking records we distinguished three stages of intensity of development and within these we examined the frequency of the winter growth type.

The results show that from the combinations slightly reacting or not reacting to the short day, strains quick or medium-quick in development have been selected. For the most part it was surprising that in the F_4 of the *Bezostaya*

1 × *Fertődi 293* we hardly found slow developing forms similar to the *Fertődi 293*, while in the F_5 of the *Bezostaya 1* × *San Pastore* 13 per cent of the plants were of the slow-developing type. The data of the F_5 strains of the *Bezostaya 1* × *Produttore 6* explain the rather lagging heading dynamics noted when examining the effect of day length, for relatively many slow-developing forms were found among them. The data of the strains originating from crosses between parents of various growth types and development show that there is a relation between the two properties. Those having slow development are almost all prostrate, while the majority of those of quick development are of the semi-erect growth type. It is interesting to note that no once has the erect growth type occurred among the three combinations.

Discussion

The study of the day length requirements of wheat varieties originating from various geographical zones shows that after the completion of the vernalization period the different varieties began to develop at various day lengths and their development passed into the next phase when illumination became important. Groups of varieties can be established on this basis. Hungarian varieties, the examined West European varieties and the *Mironovskaya 808* require long day periods for the beginning of their early spring development and for the following normal development. At the same time 12 and even 10 hours of day length have proven satisfactory for the second group. From this it seems that during shorter days (10—12 hours) the speed of the development depends on the interaction between day length, temperature and the specific photoperiodic requirements of the particular variety. Thus after vernalization and after reaching certain threshold values of temperature, light plays the leading role in the spring development of wheat.

The facts that the genetic variability of the hybrids of varieties requiring different lengths of lighting is great and that among them occur many forms not requiring long periods of light for starting their early spring development make the hypothesis feasible that during breeding such forms can be selected that need a longer period from the start of spring development until heading. It is during this period that the number of spikelets/spike or the grain number is established among the yield-forming organs. It is known that the longer the time required for organ formation, the greater will be the yield. This seems to be proved in case of several very productive wheat varieties, such as *Bezostaya 1*, *San Pastore*, *Etoile de Choisy*. The very productive West European varieties also require a longer time for organ formation as with their late start in developing in spring they will head and ripen even later.

On this basis it can be determined that in Hungary the maximum output wheat variety best for Hungary should be better sought among varieties having an inclination toward a short day-cycle or indifferent to the length of photoperiod. This may be the way to be able to bridge over the negative correlation between earliness and productiveness or while maintaining the growing period the time necessary for organ formation can be lengthened by the earlier start of the spring development of the particular variety and thus production can be increased. Such forms are — of course — to be provided with excellent cold resistance, for if not, the wheat that began to develop in the February temperature and lighting can be destroyed by the possible frosts in March.

The early spring development of the A strains selected from the hybrid population under natural conditions shows that we can easily obtain forms that begin to develop early out of the populations originating from crosses between partners having various types of spring development. Moreover we have to closely follow the further changes in the growing period of such strains because otherwise we may obtain such forms that not only develop early but do head and ripen so and thus the time necessary for organ formation will be no longer, but the growing period will be shorter resulting in the reduction of productivity. We need forms that begin to develop early, head and ripen in a period optimal among Hungarian conditions (i.e., when *Bánkúti 1201* does) and thus they can profit from the growing period.

REFERENCES

Claver, F. K.—Sivori, E. M. (1950): Study of the Reaction to Photoperiod and Temperature of Three Wheat Varieties (in Argentina) Rev. Fac. Agron., La Plata, **27,** 129—140.

Dantuma, G. (1954): Daglengte-onderzoek bij tarwe en gerst. Vierde Cocobro Jaarboekje, 62—69.

Feekes, Ir. W. (1941): De tarwe en haar milier. Verslagen van de Technische Tarwe Commissie, 523—888 Gebr. Hoitsema N. V. Groningen.

Garner, W. W.—Allard, H. A. (1920): Effect of Relative Length of Day and Night and Other Factors of the Environment on the Growth and Reproduction in Plants. J. agric. Res., **18,** 553—606.

Gries, G. A.—Stearns, F. W.—Caldwell, R. M. (1956): Responses of Spring Wheat Varieties to Day-length at Different Temperatures. Agron. J., **48,** 29—32.

Hänsel, H. (1955): Mehrjährige Frühjahrs-Saatzeiten-Versuche mit Winterweizen. Ein Beitrag zur entwicklungsphysiologischen Sortencharakteristik von österreichischen und anderen Winterweizen. Bodenkultur, **8,** 182—194.

Klebs, G. (1918): Physiologie der Fortpflanzung. Handwörterb. Naturw., 4.

Lysenko, T. (1928): A Study of the Effect of Thermic Factors upon the Duration of Development Stages of Plants. Azerbayan Plant Breed. Sta. Bull., **3,** 169.

Lysenko, T. D.—Prezent, I. I. (Лысенко, Т. Д.—Презент, И. И.) (1948): Селекция и теория стадийного развития растений. Агробиология. Сельхозгиз.

Rimpau, R. H. (1958): Untersuchungen über die Wirkung von kritischer Photoperiode und Vernalization. Z. Pflanzenzüchtg., **40,** 275—318.

Rudorf, W. (1939—1956): Entwicklungsphysiologische Grundlagen der Pflanzenzüchtung. Handb. d. Pflanzenzüchtung **1,** 153—210, 225—307.

Schmalz, H. (1953): Entwicklungsphysiologische Untersuchungen am Saatweizen, Triticum aestivum, insbesondere über die Bedeutung der photoperiodischen Veranlagung für die Ausbildung der Sortencharaktere. Z. Pflanzenzüchtg. **32,** 27—28.

Wienhues, F. (1961): Frühreife und Ertragsbildung beim Weizen in Abhängigkeit von der entwicklungsphysiologischen Veranlagung und den Klimafaktoren Licht und Temperatur. Zeitschrift für Pflanzenzüchtung. Berlin, **46,** 46—66.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 139—150 (1968)

ROOT DEVELOPMENT INVESTIGATIONS ON JONATHAN APPLE TREES GRAFTED ON M IV STOCK

By

J. TAMÁSI

RESEARCH INSTITUTE FOR HORTICULTURE, BUDAPEST—BUDATÉTÉNY

The paper deals with the root development of one- to six-year-old spindle-bush *Jonathan* apple trees grafted on *M IV* stock and grown on sand soil according to the cultural practices used in Hungarian large-scale orchards. The results revealed that the dressing method applied so far did not follow suitably the annual development and areal expansion of apple tree roots.

Introduction

The field examination of the root system of fruit trees requires very meticulous, strenuous and pertinacious work. The pertaining Hungarian investigations are insignificantly few and confined to those carried out by BALLENEGGER (1934, 1937, 1938) and MOHÁCSY jr. (1953) on some specimens of bearing and non-bearing age. Abroad prior to the thirties the so-called drip theory was set up by KERNER (1888), according to which the absorbing roots of fruit trees are located in the soil in compliance with the projection of the crown, the so-called "drip". Contemporary fruit growers elaborated the dressing system of fruit trees on the basis of this theory. Numerous investigation data on fruit trees of bearing age published by KVARAZKHELIA (1930) in the thirties proved the indefensibility of the "drip theory" and called the attention to the superficial dressing of the whole area of orchards. On the strength of this establishment the great majority of fruit growers turned over to the dressing of the entire surface of orchards. In contradiction with the dressing of the whole area and in order to eliminate the alternation of apple trees SZAKÁTSY (1956) suggested the individual treatment, i.e. to dress only the area around each tree depending on its bud set. These basic but essentially conflicting establishments drew the attention to the investigation of the root system of various fruit tree species of different ages, grafted on various stocks and growing under special conditions.

Material and Method

The examined 1- to 6-year-old spindle-bush *Jonathan* apple trees grafted on *M IV* stock have been grown with 7×4 m spacing on sand soil in the dry cultivated apple orchard of the Nyírlúgos State Farm belonging to the Nyírség geographical region. The site has a dune-like, somewhat undulating surface and is situated in 110 to 115 m altitude above sea level. Its base rock consists of sand on which, under the influence of the woody vegetation, a rust brown forest soil with a thin humus layer has developed. The soil shows a neutral or slightly acid reaction, its water management is weak, the nutrient management unfavourable, the aeration good, the humus content low; with nitrogen and phosphorus it is weakly, with potassium moderately supplied.

Each 1-year-old tree was dressed with 20 kg organic manure, 400 g phosphorus and 250 g potassium; in the following year with 20 kg organic manure, 300 g nitrogen; in the 3rd year with 25 kg organic manure, 500 g N, 600 g P, 400 g K. In the 4th year they obtained 1 kg N, 600 g P, 800 g K; in the 5th year 50 kg organic manure, 2 kg N, 1.2 kg P and 2 kg K and in the 6th year 2.5 kg N, 1.5 kg P and 2 kg K. These dressing materials were broadcast superficially under the branch system and worked lightly into the soil. Between the rows rye or rape was sown for green manuring every year. The annual quantity of the ploughed-in green manure amounted to 500 to 600 kg per cadastral yoke (= 1.42 acre = 0.575 ha).

During the last 10 years the examined area and its vicinity had received 562 mm precipitation annually in the average and in a relatively favourable distribution, because 50 per cent of its quantity had fallen in the period from May to September.

The position of the root system of the examined 1- to 6-year-old trees grafted on *M IV* stock was fixed by the aid of the so-called "Skeleton method", i.e. the growing space of all 9 trees in each age class was divided by a wirework into quadrats of 1 square meter. Subsequently within a circle of 80 cm diameter surrounding the tree the soil was carefully excavated disengaging thus the skeleton roots and partly their ramifications. Starting from the stem first the skeleton root next to the soil surface and all its ramifications were released from the soil and simultaneously their picture fixed according to a certain scale and the data registered.

This examination method permits to disclose the different moments of root growth as a function of the species and variety of the fruit tree, of its stock, age, soil conditions and agricultural practices. By this procedure there may be studied also soil properties that damage the development of the root system and probably inhibit the establishment of a new orchard (hardpan, high ground water table etc.).

Results and Discussion

The roots of younger than 1- to 6-year-old *Jonathan* apple trees, grafted on *M IV* stock have a bright yellow colour, the older ones are brownish-yellow. From the starting point to their tip both the younger and older roots are covered with rootlets. Beginning already with the first year a wreath-like root system composed of radially and ringwise growing longer or shorter roots is developing around the stems and that contains also thin absorbing roots characterizing the individual peculiarity of the stock. During his investigations TAMÁSI (1965) observed that around apple trees grafted on wild stock a similar absorbing region developed to a considerably minor extent and only from the age of 3 to 4 years. The examinations conducted by ROEMER—HILKENBÄUMER (1937) revealed that fibre roots developed abundantly and characteristically of *M* stocks even around 25-year-old trees grafted on *M* stock.

In the course of subsequent research in each age class the quantity per tree of roots 0.1 cm or more in diameter as the average of 9 trees was established, in order to find out the mutual relation of the different thick roots using identical stocks of the same age and on the same soil type (Table 1).

The data demonstrate that the quantity of 0.1 to 0.5 cm thick roots of one-year-old apple trees grafted on *M IV* stock quadrupled and those of two-year-old trees doubled in the 3rd year, indicating the increased horizontal and vertical expansion of the root system and the multiplying of its nutrient

Table 1

Quantitative development of roots 0.1 cm and more in diameter of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in sand soil

Diameter of the roots, cm	Quantity of the different thick roots per stem in the average of Jonathan apple trees aged					
	1 year	2 years	3 years	4 years	5 years	6 years
0.1–0.5	81.5	159.0	354.3	307.8	372.7	444.3
0.6–1.0	4.0	15.4	31.4	63.7	48.5	40.7
1.1–1.5	4.0	5.0	11.0	22.3	13.5	14.7
1.6–2.0	0.5	3.2	7.1	8.9	5.5	4.7
2.1–2.5	—	0.3	2.2	4.3	3.5	3.8
2.6–3.0	—	0.1	0.7	2.6	2.0	1.5
3.1–3.5	—	—	—	1.7	1.8	2.6
3.6–4.0	—	—	—	0.3	1.0	0.7
4.1–4.5	—	0.5	0.1	1.5	0.6	1.7
4.6–5.0	—	—	—	0.6	0.7	0.8
5.1–5.5	—	—	—	0.5	0.6	0.6
5.6–6.0	—	—	—	0.8	0.2	—
6.1–6.5	—	—	—	—	—	0.2
6.6–7.0	—	—	—	0.2	—	0.3
7.1–7.5	—	—	—	—	—	0.1
7.6–8.0	—	—	—	0.4	—	—
Total	90.0	183.5	406.8	415.6	450.6	516.7

absorption surface as well. The quadrupling and doubling, respectively, of the quantity of roots on the one- and two-year-old trees respectively coincide in reality with the conspicuous, energetic development of young trees following their weaker growth after plantation. In case of *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil this obviously stronger development occurs in the 3rd year.

From the aspect of nutrient uptake the 0.1 to 0.5 cm thick roots are very valuable, because they produce the greatest amount of rootlets bearing root hairs. Until the 6th year the quantity of all 0.1 to 0.5 cm thick roots successively increases (Fig. 1).

Comparative examination on the root and branch system of Jonathan apple trees grafted on M IV stock

As it was mentioned above, until the age of six dressing materials used to be broadcast under the branch systems and poorly worked in. Fertilizers can suitably be broadcast on the field only, if the expansion and location of branch systems in the space air and those of root systems in the soil are well known.

Fig. 1. Partly excavated root system of a six-year-old spindle-bush *Jonathan* apple tree grafted on *M IV* stock and growing in sand soil. The so-called "root wreath" consisting of thinner roots and surrounding the stem is clearly visible

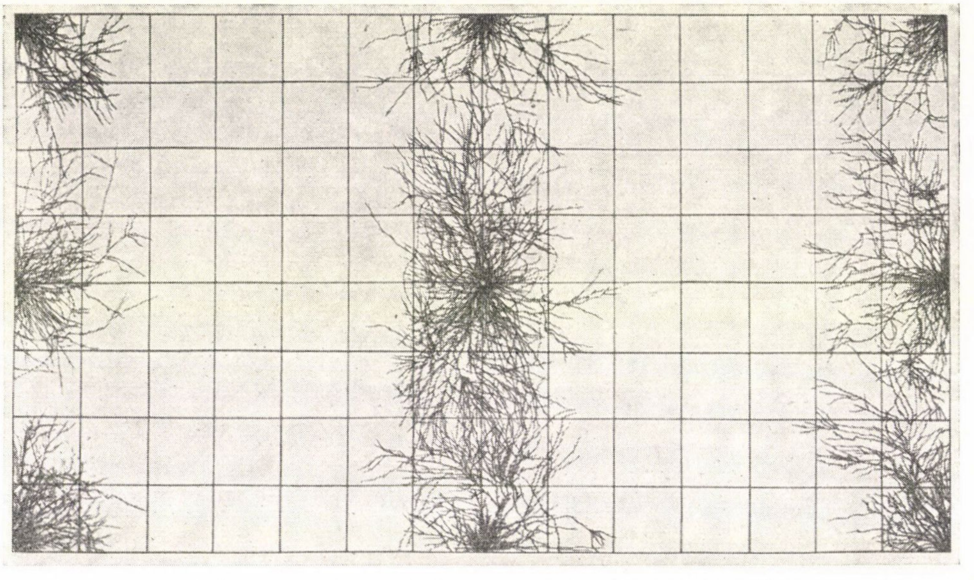


Fig. 2. Top-view of the root system of three-year-old, spindle-bush *Jonathan* apple trees grafted on *M IV* stock and planted in sand soil with 7×4 m spacing. The projection of the crown (drip) is marked by a dotted line. The areal extension of the root system is double that of the branch system

A methodical comparative examination of the over- and underground parts has revealed that on sand soils of loose structure and of less favourable water and nutrient management there exists no identity between the extent of root and branch systems of 1- to 6-year-old *Jonathan* apple trees grafted on

M IV stock, then the surface to be fertilized cannot be determined on the basis of the annual development and areal expansion of branch systems (Fig. 2).

KEMMER (1947), in the course of his investigations with 1- to 6-year-old apple trees grafted on type stocks and grown on clay soil, came to a contrary result and pointed out that in clay soil the diameter of the branch system would be exceeded by the root system only from the 6th year on. The data of examinations performed by the author (TAMÁSI, 1966) on root development in clay soil corroborate entirely the above establishment of KEMMER (1947).

Weight proportions of the over- and underground parts of Jonathan apple trees grafted on M IV stock

According to ROGERS and VYVYAN (cit. KOBEL, 1954) from the weight proportion of the over- and underground parts a conclusion can be drawn as to the nutrient richness of the soil, this proportion being 1 : 1 in soils containing few nutrients. This statement is probably valid only for trees of older bearing age. From the examined 1- to 6-year-old apple trees grafted on *M IV* stock and growing in sand soil total and mutual weights of root, stem and branch system taken in fresh state and — per age class — for one averagely developed tree have been determined. The data thus obtained are presented in Table 2.

Table 2

Weight proportion of the under- and overground parts of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in sand soil

Age of the examined trees	Total weight of under- and overground parts in fresh state	Weight of the root system in fresh state	Weight of the stem in fresh state	Weight of the branch system in fresh state	Weight proportions of the under- and overground parts
years	kg	kg	kg	kg	
1	1.00	0.40	0.31	0.29	1 : 1.5
2	3.36	1.36	0.53	1.47	1 : 1.4
3	9.83	3.69	1.65	4.49	1 : 1.6
4	27.60	9.80	4.30	13.50	1 : 1.8
5	38.60	14.45	3.65	20.50	1 : 1.6
6	45.01	19.36	3.20	22.45	1 : 1.3

From the results it may be seen that until the 4th year the weight proportion of the over- and underground parts successively increases in favour of the latter, but gradually diminishes at the age of five and six. Starting from the fact that the examined trees have grown in a soil of poor nutrient supply, of unfavourable water management and drifting sand feature, the change in the proportion of over- and underground parts cannot be explained by a steady increase of the nutrient contents in the soil but it can be traced back to the fact that the roots penetrating the underground more abundant in water are steadily growing in number and exert a high root-forming intensity.

It is known that when grafted trees are lifted from the nurseries and their roots cut back immediately before planting, weight proportions shift considerably in favour of the overground parts and at the expense of the organs in the soil. In the case discussed here this proportion was 1 : 1.5 at the age of one. From the 2nd till the 4th year the overground parts showed a more powerful development, which reacted — from the 5th year — upon the sturdier growth of root system as a consequence of the rapid increase of the assimilating surface. At the age of six the weight of roots comes nearly up to that of the overground parts. Parallel with the annual multiplying of root mass the difference between the weight rates of the under- and overground parts is regularly decreasing, and it may be assumed that with advancing age the weight proportion of the under- and overground parts becomes balanced reaching 1 : 1.

Areal extension and distribution of the root system of Jonathan apple trees grafted on M IV stock

The root system of the examined 1- to 6-year-old *Jonathan* apple trees grafted on *M IV* stock has covered different large areas. The length of roots 0.1 cm and more in diameter, the extent of the area covered by them as well as the length of roots per square meter (m^2) inside and outside the drip have been established as the average of 9 trees in each age class (Table 3).

The data thus obtained and presented in Table 3 show that in the 3rd year the length and quantity respectively of the root system exceeded the treble of the first year's values, multiplied ninefold in the 4th and tenfold in

Table 3

Areal extension and distribution of the root system of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in sand soil

Age of the examined roots	Average length of the roots thicker than 0.1 mm	Average extent of the area covered by the root system	Average extent of the area limited by the drip	Average extent of the area covered by the root system outside the drip	Average length of the root system located within the drip	Average length of the root system located outside the drip
year	m	m^2	m^2	m^2	m	m
1	37.91	4.0	0.33	3.66	18.64	19.50
2	120.11	9.5	5.10	4.45	103.37	16.74
3	245.47	14.4	4.40	10.02	153.45	92.05
4	358.37	22.5	7.84	14.67	309.85	48.52
5*	407.68	29.1	11.86	17.25	341.32	66.36
6	399.86	28.1	13.70	14.40	337.46	62.39

* The development of the root system of five-year-old trees was somewhat more powerful than that of the stems aged six. This may probably be attributed to a fairly compact layer of better water and nutrient management under the surface of the soil.

the 6th year. The root system of *Jonathan* apple trees grafted on *M IV* stock covered at the age of one an area of 4 m^2, in the second year 9.5 m^2, in the 3rd year 14.4 m^2 and in the 6th year 28.1 m^2.

Accordingly — considering the horizontal extension of the root system of one-year-old spindle-bush *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil —, the extent of the area to be dressed should be established as a 2 m broad stripe by measuring 1 m each outward from the stems right and left, in the direction of the spacings. Similarly, for the two- and three-year-old trees in both directions 2 m (altogether 4 m), while for the four-year-old trees 5 m and for those aged five and six, 6 and 6.5 m broad stripes should be dressed, with regard to the one-way soil cultivation.

It is also demonstrated by Table 3 that 51 per cent of the total root length of one-year-old trees were located outside the drip, whereas from the total root length of the 2-, 3-, 4-, 5- and 6-year-old trees 14.1, 37.5, 15.0, 16.5 and 16.0 per cent were to be found outside the drip.

These data prove clearly that the method used for the treatment of young trees dressing them around the drip is untenable, so much the more, as the greatest part of root quantities belonging to the above-mentioned 16 to 51 per cent outside the drip is composed of root tips of skeleton and lateral roots bearing many rootlets; these tips ensure the further development. This statement is inconsistent with the establishment of Pasc—Prica (1961—1962), according to which till the age of four the best procedure for young apple trees is to add fertilizers and manures into furrows dug in the area of the drip.

Location and distribution according to depth horizons of the root system of Jonathan apple trees grafted on M IV stock

The distribution according to depth horizons of the examined 1- to 6-year-old *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil is presented in Table 4.

From the data of this Table it turns out that the depths reached by the root system of the *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil vary according to age classes, i.e.: with advancing age a certain rate of the root system penetrates successively deeper into the soil. The greatest depth touched by some roots at the age of one was 110, and in the 6th year 390 cm. On sand soils of bad water and nutrient management it is not indifferent what percentage of the whole root system of the different stocks penetrates into the fairly moist subsoil. On easily draining sand soils the geotropically growing roots have — beside the fixing of the stems — a very great importance in ensuring the undisturbed water supply for the trees (Fig. 3).

The data of Table 4 also demonstrate that from the roots of the one-year-old spindle-bush *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil 7.15 per cent are located in the upper soil layer of 0 to 20 cm. The respective values in the 2nd, 4th, 5th and 6th year are 22.8, 19.2, 18.1 and

Table 4

Percentual distribution in the different depth horizons of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in sand soil

Depth horizons	Percentual distribution of the root system of trees aged					
cm	1 year	2 years	3 years	4 years	5 years	6 years
0— 10	0.39	2.06	7.45	2.09	1.90	1.40
11— 20	6.76	20.73	35.25	17.14	16.19	16.74
21— 30	22.36	20.76	12.92	13.74	16.45	17.02
31— 40	23.85	12.06	10.61	11.87	17.08	13.14
41— 50	18.83	10.81	8.43	11.76	11.82	15.64
51— 60	10.62	3.18	7.56	11.99	7.93	9.51
61— 70	7.75	6.83	5.58	8.59	6.23	6.59
71— 80	5.84	4.76	3.36	6.39	4.92	3.20
81— 90	3.48	4.46	2.01	4.72	3.89	2.29
91—100	0.11	4.13	1.65	3.25	3.05	1.80
101—110	0.01	2.53	1.09	2.09	2.08	1.95
111—120	—	2.11	0.93	1.50	1.56	1.82
121—130	—	2.01	0.78	1.20	1.41	1.26
131—140	—	0.91	0.66	0.95	1.19	1.16
141—150	—	0.70	0.57	0.68	0.98	0.97
151—160	—	0.57	0.39	0.55	0.81	0.76
161—170	—	0.43	0.27	0.45	0.70	1.12
171—180	—	0.35	0.22	0.45	0.59	0.79
181—190	—	0.21	0.14	0.32	0.44	0.70
191—200	—	0.14	0.09	0.17	0.29	0.47
201—210	—	0.09	0.03	0.09	0.24	0.31
211—220	—	0.06	0.01	0.03	0.15	0.21
221—230	—	0.06	—	0.01	0.08	0.18
231—240	—	0.05	—	—	0.02	0.14
241—250	—	—	—	—	—	0.13
251—260	—	—	—	—	—	0.11
261—270	—	—	—	—	—	0.11
271—280	—	—	—	—	—	0.11
281—290	—	—	—	—	—	0.09
291—300	—	—	—	—	—	0.06
301—310	—	—	—	—	—	0.06
311—320	—	—	—	—	—	0.05
321—330	—	—	—	—	—	0.03
331—340	—	—	—	—	—	0.03

Table 4 continued

Depth horizons	Percentual distribution of the root system of trees aged					
cm	1 year	2 years	3 years	4 years	5 years	6 years
341—350	—	—	—	—	—	0.01
351—360	—	—	—	—	—	0.01
361—370	—	—	—	—	—	0.01
371—380	—	—	—	—	—	0.01
381—390	—	—	—	—	—	0.01
Total	100.0	100.0	100.0	100.0	100.0	100.0

Fig. 3. The figure demonstrates clearly the geotropically growing roots stirring up the subsoil richer in water

18.5 per cent, but at the age of three — due to a more compact spot in the subsoil — 43.0 per cent of the roots are to be found in the 0 to 20 cm layer. This shallow location of a large root mass precludes — in some cases — the possibility of deep soil cultivation. To avoid severance of thicker roots within the drip the depth of soil cultivation must not exceed 12 to 15 cm. Outside the drip the soil may safely be cultivated to a depth of 20 to 25 cm, as the thinner roots located in the peripheral parts can easily regenerate (Fig. 4).

The foregoing is also confirmed by the investigations of METLICKY (1956) and SOCZEK (1954). According to the former the deep cultivation of the orchard is dangerous, as wounds to the roots may cause serious damages. In the latter's opinion the deep cultivation of orchards depends on the depth of thicker roots. These two opinions may be agreed with because TAMÁSI (1962) — to gather information — has achieved similar results in the course of his investigations by cutting off a 9.2 cm thick root at its base from the stem. This relatively not too thick root and all its ramifications covered an area of 67 m^2. Accordingly, it is highly important to give only a light cultivation to the soil around the stems, as the cutting of some thicker roots may lead to great losses in the nutrition of the tree.

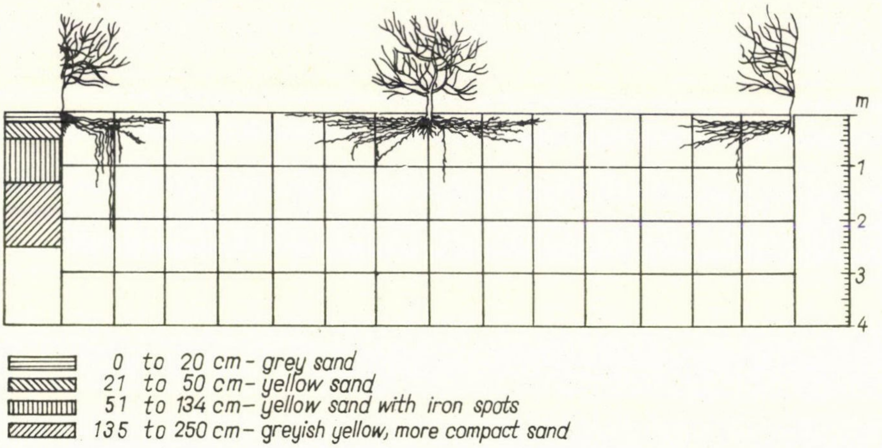


Fig. 4. Lateral view of the root system of three-year-old spindle-bush *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil. The side of the squares is 1 m long. The drawing demonstrates the location of the root system in different depths

Conclusions

The younger and older roots of the examined 1- to 6-year-old *Jonathan* apple trees grafted on *M IV* stock are equally characterized by the mass of rootlets covering the whole root surface. Dealing with trees of this age we cannot speak of sharply delimited, so-called nutrient absorbing zones, because the roots, coming into contact with the nutrients, are able to uptake them with their whole surface.

It is a characteristic feature of the roots of the *M IV* stock that, beginning with the first year, a wreath-like root system is being developed around the stems which is composed of longer or shorter roots and of radially ringwise arranged thin absorbing roots, indicating the importance to the nutrient supply of the area under the branch systems.

The *M IV* stock has a rather shallow root system, and the different roots cannot penetrate as deep and wide as those of the wild stock.

Between the expansion of root and branch systems of spindle-bush *Jonathan* apple trees grafted on *M IV* stock and growing in sand soil no similarity exists. At the age of one to six years the diameter of branch systems cannot be considered as the basis of the surface to be dressed.

The examined *Jonathan* apple trees covered the following areas with their root system: in the first year 4 m^2, in the 2nd, 3rd, 4th, 5th and 6th years 9.5, 14.4, 22.5, 29.1 and 28.1 m^2 respectively. Knowing these data, the extent of the surface to be dressed under the one-year-old *Jonathan* apple trees grafted on *M IV* stock with 7×4 m spacing should be determined as a 2 m broad stripe, by measuring 1 m each outward from the stems right and left in the direction of the spacings. Similarly for the 2- and 3-year-old trees in both directions 2 m (altogether 4 m), while for the four-year-old trees 5 m and for those aged five and six 6 and 6.5 m broad stripes should be dressed.

From the root system of 1- to 6-year-old trees 7.5 to 43 per cent were found in the depth of 0 to 20 cm.

The greatest part (82.8 per cent) of the root system of the one-year-old trees penetrated into a depth of 60 cm. The respective values for the root system of trees aged 2, 3, 4, 5 and 6 (representing 76.4, 82.4, 83.6, 82.5 and 80.0 per cent respectively of all roots) were 70, 60, 80 and 70 cm respectively.

Knowing the quantity of roots located in the upper layer of 0 to 20 cm it is evident that — to avoid serious damages of the root system — the depth of soil cultivation within the drip must not exceed 12 to 15 cm. Outside the drip the soil may safely be cultivated to a depth of 20 to 25 cm.

The data on the location of the root system in the soil may give real advice as to the thickness of the profile to be soaked in case of supplementary irrigations applied from time to time.

REFERENCES

Ballenegger, R. (1934): A gyümölcsfa gyökerei és a talajviszonyok (The Roots of Fruit Trees and Soil Conditions). Természettudományi Közlöny, **66**, 57—65.

Ballenegger, R. (1937): Adatok az őszibarack termőhely ismeretéhez (Contributions to the Knowledge on the Site of Peach Trees). M. Kertészeti Tanintézet Közleményei, **3**, 3—28.

Ballenegger, R. (1938): Gyümölcsfa gyökérképek (Root Pictures of Fruit Trees). M. Kertészeti Tanintézet Közleményei, **4**, 10—15.

Kemmer, E. (1947): Die Gestaltung der Wurzelkrone bei Obstgehölzen. Erw. Obstbau, **4**, 11.

Kerner, A. (1888): Pflanzenleben. Leipzig.

Kobel, F. (1954): Lehrbuch des Obstbaues. Springer, Berlin—Göttingen—Heidelberg, 62—74.

Kvarazkhelia, T. (1930): Beiträge zur Biologie des Wurzelsystems der Obstbäume. Die Gartenbauwissenschaft, **4**, 241—341.

Metlicky, Z. A. (Метлицкий, З. А.) (1956): О технике обработки почвы в садах. Сад и огород. **3**, 450—451.

Mohácsy, M. jr. (1953): Faiskolai trágyázási és talajelőkészitési kisérlet (A Dressing and Soil Preparation Experiment in the Nursery). Kertészeti és Szőlészeti Főiskola Évkönyve, **17**, 43—58.

Pasc, I.—Prica, D. (1961—62): Influenta ingrasamintelor organice si minerale asupra cresterii si dezvottarii pomilortineri der mor si prun in conditile bazinulni Geogain din regunoa Hunedoara. Lucrari Stiintifice. Ed. Agro-Silvica. **5**, 347—356.

Roemer, T. H.—Hilkenbäumer, F. (1937): Wurzelstudien an 25jährigen Kernobstbäumen. Kühn-Archiv. B. 42.

Soczek, Z. (1954): Uprawa gleby a system korzeniony drzew. Prz. Agr., **3**, 2—4.

Szakátsy, Gy. (1956): Az almafák rendszeres termésének biztosítása (How to Assure a Regular Yield of Apple Trees). Mezőgazdasági Kiadó, Budapest. 26—27.

TAMÁSI, J. (1962): Zárttelepítésű vadalanyra oltott Jonathán almafák gyökérfeltárásának agrotechnikai vonatkozásai (Data on the Agricultural Practices of Root Excavation of Closely Planted Jonathan Apple Trees Grafted on Wild Stock). Kísérletügyi Közlemények. Kertészet, **3**, 87—117.

TAMÁSI, J. (1965): Vadalanyra oltott, zárttelepítésű 1—6 éves Jonathán almafák gyökérzetének elhelyezkedése homoktalajban (The Location of the Root System of 1- to 6-year-old, Closely Planted Jonathan Apple Trees Grafted on Wild Stock and Growing on Sand Soil). Növénytermelés, **14**, 115—148.

TAMÁSI, J. (1966): Az almafák gyökérzetének helyzete a talajban és fejlődésének kihatása az agrotechnikára (The Position of the Root System of Apple Trees in the Soil and the Effect of its Development on Agricultural Practice). Dissertation, Budapest. 1—210.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 151—160 (1968)

EXAMINATION OF THE F_1 HYBRIDS OF AEGILOPS CYLINDRICA HOST × TRITICUM AESTIVUM L.

By

A. BELEA

AGRICULTURAL RESEARCH INSTITUTE OF THE HUNGARIAN ACADEMY OF SCIENCES, MARTONVÁSÁR

The fertility, morphological and other characteristics of the hybrids of the different varieties of *Aegilops cylindrica* Host and *T. aestivum* L. have been studied. The crossing of the two species seems to be relatively successful. The plants of the first generation are uniform and the majority of their morphological characteristics are intermediary.

Introduction

As it is known the *Aegilops* family, as a close relative of wheat, played a decisive role in the genesis of cultivated wheat. Certain authors, for instance PERCIVAL (1921) accept the so-called "Aegilops hypothesis" according to which the *T. aestivum* L. species is the amphidiploid (reduced) form of *T. dicoccum* Schübl. and *Aegilops cylindrica* Host. Even VAVILOV (1949) holds that the D genome of *Aegilops cylindrica* Host corresponds to the third genome of common wheat.

Since MCFADDEN—SEARS (1944, 1946) had obtained the *T. spelta* L. from crossing *T. dicoccoides* Körn. and *Aegilops squarrosa* L. and later KIHARA—LILIENFELD (1949) had achieved the same results with *T. dicoccum* Schübl. and *A. squarrosa* L. it was proved that the D genome had got into the common wheat species through amphidiploidization from *Aegilops squarrosa* L. These authors assume that the *T. aestivum* L. species has originated from the crossing of *T. spelta* L. and *T. vulgare antiquorum* (KISS 1965). It is also a known fact that *Aegilops cylindrica* Host was successfully produced through the amphidiploidization of the *Agropyron triticeum* (B) × *Aegilops squarrosa* L. (D) hybrids. Consequently it is very likely that the third genome (D) of *T. aestivum* L. directly originated from *Aegilops squarrosa* L. and only indirectly from *Aegilops cylindrica* Host.

The most recent cytological and genetical studies have proved the close relation between the two *Aegilops* species and *T. aestivum* L. According to data from crossings the chromosome units of *Aegilops cylindrica* Host and *A. squarrosa* L. pair only with the third genome of hexaploid wheat and not with the tetraploid species. Similarly, a close relation is supposed by the spontaneous crossing between the mentioned species of the two families which has been by several authors examined among natural conditions. The publication of GODRON (1869) and that of the Hungarian DEGEN (1917) deserve special attention. In 1933 the latter author found on the island of Szentendre spontaneous hybrids of *Aegilops cylindrica* Host $\times$ *T. aestivum* L. named by him *Aegilops Sancti-Andreae Deg. Hybr. nov.* In 1954 RAJHÁTHY visited the site and found a multitude of natural hybrids of the two species. The 200 hybrids subjected to tests proved to be sterile; some grains were found in only 6 plants (LELLEY—RAJHÁTHY 1955, RAJHÁTHY 1960). POPOVA (1923) also reports on the large degree of sterility in F_1 hybrids.

In addition to the mentioned authors TCHERMAK (1913) who had first produced hybrids by artificially crossing *Aegilops cylindrica* Host and *T. aestivum* L. mentioned the sterility of pollen in his study on the viability of the stigma. VAVILOV (1949), PRIADCENCU—MELACRINOS (1957) etc. also noted that the anthers did not open.

On the other hand the anthers of the spontaneous hybrids examined by DEGEN (1917) contained a great amount of apparently well-developed pollen, 18 per cent of which grew pollen tubes.

A great part of the data obtainable from literature (VAVILOV 1949; DEGEN 1917, etc.) reports on the intermediary type of the F_1 hybrid of *Aegilops cylindrica* Host $\times$ *T. aestivum* L. LELLEY—RAJHÁTHY (1955) regard the transitional character of the F_1 plants to be only apparent as the hybrids bear certain characters of the parents, in a mosaic-like way. This hybrid character, however, differs — in the author's view — for each combination.

Material and Conditions

In my study I report on the genetic analysis of F_1 hybrids and about the crossings between *Bezostaya 1*, *B. 1201*, *Mironovskaya 808*, *F. 293*, *Skorospelka*, *Etoile de Choisy* and *Produttore* varieties belonging to the *Aegilops cylindrica* Host (2n = 14, CCDD) and *T. aestivum* L. (2n = 42, AABBDD) species.

The received F_1 grains were planted together with the parents in properly prepared small pots on October 6, 1964. After reaching the required stage of development the plants were set out in a 30×30 cm plot on March 22 of the following year.

The F_1 plants were examined and treated individually. These observations included, in addition to the phenological examinations (sprouting, tillering, heading, ripening etc.), mainly the evaluation of the morphological traits of the spike and the quantitative properties (height of plant, length and compactness of spike, productive tillering, spikelet number per head, length and width of glume, number of grains per plant and head).

In examining rust resistance *(Puccinia graminis* Perc. and *Puccinia recondita* Rob. ex Desmf. sp. *tritici)* classification was done only among conditions of natural infection. Evaluation was based on the usual STAKMAN (1915) and ROEMER—FUCHS *et al.* (1939) scale (0 = very resistant, 1 = resistant, 2 = moderately resistant, 3 = weakly susceptible, and 4 = very susceptible).

Crossings were done by tweezers castration and the anthers were placed on the stigma with the help of tweezers. The pollen was examined through a Lumipan microscope at a magnification of 10×8. The percentage was averaged from the number of pollen well or poorly stainable with carmine acetic acid which was found in the ten fields. By functional pollen we mean regularly-shaped, granular pollen, well stainable with carmine acetic acid.

Results and Discussion

Crossability. During our experiments a fairly good seed setting was obtained in the crossings between the different varieties of *Aegilops cylindrica* Host and *T. aestivum* L. (10.0—32.5 per cent). As it can be seen from Table 1 the germination percentages of the F_1 grains were also adequate (50.0—88.8 per cent).

Table 1

Crossing data of Aegilops cylindrica Host × T. aestivum L.

Combination	Crossed flowers No.	Grains gained No.	Seed set %	Germination percentage
Aegilops cylindrica × Bezostaya 1	60	13	21.6	84.5
Aegilops cylindrica × Mir. 808	30	9	30.0	88.8
Aegilops cylindrica × Skorospelka	42	8	19.0	50.0
Aegilops cylindrica × F. 293	30	3	10.0	66.6
Aegilops cylindrica × B. 1201	30	9	30.0	88.8
Aegilops cylindrica × Etoile de Choisy	30	9	30.0	88.8
Aegilops cylindrica × Produttore	40	13	32.5	76.9

Fertility examinations. Well-stainable pollen could hardly be observed in the anthers of the F_1 plants of *Aegilops cylindrica* Host × *T. aestivum* L. (Table 2). The anthers did not open in the F_1 hybrids of *Aegilops cylindrica* Host × *Produttore*, where the number of poorly stainable pollen had been the lowest.

In our examinations the actual sterility has been expressed in the number of grains per spike. Due to the large degree of sterility the number of grains

Table 2

Pollen sterility and spike productivity of the Aegilops cylindrica Host × T. aestivum L. F_1 hybrids

Name	Examined plants No.	Examined pollen No.	Unstainable pollen %	No. of grains/plant	No. of grains/spike
Aegilops cylindrica × Bezostaya 1	11	720	95.9	0.81	0.09
Aegilops cylindrica × Mir. 808	8	615	96.5	0.25	0.03
Aegilops cylindrica × Skorospelka	4	285	93.1	1.50	0.33
Aegilops cylindrica × F. 293	2	196	85.2	0.75	0.08
Aegilops cylindrica × B. 1201	8	439	88.1	0.13	0.02
Aegilops cylindrica × Etoile de Choisy	8	803	89.7	0.13	0.01
Aegilops cylindrica × Produttore	10	390	75.5	0.00	0.00
Aegilops cylindrica	4	230	5.4	865.60	8.10
T. aestivum (variety average)	43	2269	19.1	305.76	36.40

per plant has also been represented in Table 2. On the basis of these two values the most fertile combination proved to be the *Aegilops cylindrica* Host × *Skorospelka* (the number of grains per plant was 1.5 and the number of grains per spike 0.33).

Qualitative characteristics of F_1 hybrids. Regardless of combinations the F_1 plants of *Aegilops cylindrica* Host × *T. aestivum* L. were uniform. The spike-

Fig. 1. Spike and fracture type of *Aegilops cylindrica* Host × *Bezostaya 1* in the F_1

Fig. 2. Short-awned spike type in the F_1 of the *Aegilops cylindrica* Host × *F. 293* combination

shape of the plants of the first generation proved to be intermediary between the extremely narrow spikes of the mother plant and the prism-shaped spikes of *T. aestivum* L. (Fig. 1). Besides the intermediary characteristics which constituted the majority, certain characteristics of the parents (e.g., breaking type of *Aegilops*, the stiffness of its glume, etc.) were dominantly inherited by the F_1 plants. The hybrids were loose-headed reminding us of the *T. spelta* L. The spikelets did not so closely flatten to the rachis as experienced in the *Aegilops* parent. The rachises of the mother and hybrids were not brittle and fell apart only under strong pressure, as it may be seen in Fig. 1 with spelta-type breakage. The glume proved to be stiff and hard.

The awnless character of *Aegilops cylindrica* Host was dominant even in the crossings of the awned *Skorospelka*, *F. 293* and *B. 1201* varieties where only short awn projections could be noted on the hybrid spike types (Fig. 2).

The shape of the glume of F_1 plants as well took position between the narrow, elongated glume shape of *Aegilops* and depending on the variety, egg-, or pear- and sometimes the thick glume form of *T. aestivum* L. (Figs 3, 4, 5).

A weak hairiness was detected on the glume margins of *Aegilops* and of the hybrids. The glume teeth located on the lower part of the spikes of the mother plants and also of the *Skorospelka*, *F. 293* and *B. 1201* varieties were

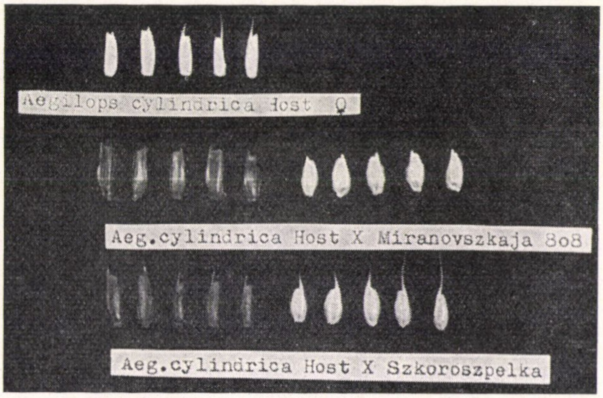


Fig. 3. Glume form of the F_1 plants of *Aegilops cylindrica* Host × *T. aestivum* L. Upper row: *Aegilops cylindrica* Host ♀. Central and bottom rows: on the left the F_1 hybrids, on the right the glumes of the father parents

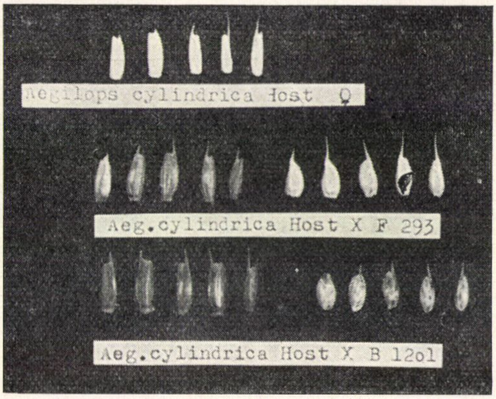


Fig. 4. Glume forms of the F_1 plants of *Aegilops cylindrica* Host × *T. aestivum* L. Upper row: *Aegilops cylindrica* Host ♀. Central and bottom rows: on the left the F_1 hybrids, on the right the glumes of the father parents

hardly discernible. In the medium and upper third of the spikes the glume teeth were, however, very expressed and in a few cases there were short awns (5—7 mm). This was noted also on the F_1 hybrids of the mentioned parental partners. On the two uppermost glumes of the flowers we found — similarly to the *Aegilops* parents — very developed awns (3—5 cm).

Generally the glume shoulder of *Aegilops cylindrica* Host is doubly pointed, as well as that of the F_1 hybrids of *Aegilops cylindrica* Host × *Produt-*

tore. The shoulder sections of the apex of the glume margins of the F_1 hybrids of *Aegilops cylindrica* Host × *Mironovskaya 808*, *Skorospelka*, *B. 1201* and *Etoile de Choisy* combinations were very expressed implying that the edge of the glume margin more or less curves out as to form almost a right angle with the glume spine. At times the glume edge steeply form an acute angle with the spine or the shoulder portion was rounded similarly to most *T. aestivum* L. varieties.

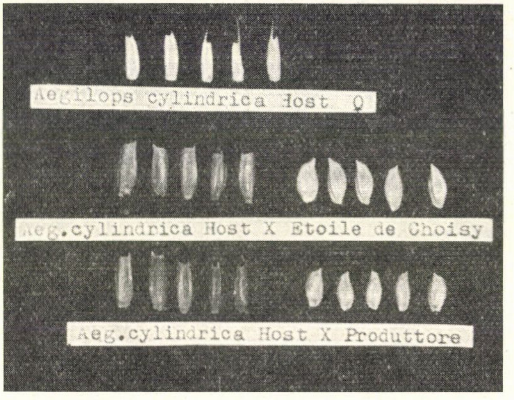


Fig. 5. Glume forms of the F_1 plants of *Aegilops cylindrica* Host × *T. aestivum* L. Upper row: *Aegilops cylindrica* Host ♀. Central and bottom rows: on the left the F_1 hybrids, on the right the glumes of the father parents

Concerning the development of the glume spine (ridge), the hybrids take a medial place between the parents. Namely in case of *Aegilops cylindrica* Host it is weakly developed i.e. hardly protruding from the glume margins. On the other hand this characteristic is striking among the *T. aestivum* L. varieties. We found small tooth-like, surface hair formations on the glume spine of the hybrids.

The glume colour of the hybrids was brown while that of the parents yellow.

Quantitative properties of F_1 hybrids. The more important standard of value (properties) of the first generation of *Aegilops cylindrica* Host and the hybrids of wheat species have been studied in comparison to the parental species.

We found that the height, spikes and glumes of F_1 plants were larger or longer respectively than those of both plants (Tables 3 and 4). This has especially been observed when examining the plant height of *Aegilops cylindrica* Host × *Mironovskaya 808* hybrid (the average height of the hybrids was 126.2 cm in contrast to the values of the parents, 51.3 and 111.6 cm respectively).

In productive tillering the F_1 hybrids were intermediary. In none of the combinations do they surpass the 108.2 average spike value per plant of the

Table 3

Data of the more important quantitative characteristics of the F_1 hybrids

Name of combination	N	Plant height			Spikes/plant			Length of spike			Spikelets/spike		
		$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$
A. cylindrica × *Bezostaya 1*	11	112.3	4.4	1.3	22.7	9.0	2.7	13.5	1.0	0.3	14.3	0.2	0.1
A. cylindrica × *Mir. 808*	8	126.2	6.4	2.2	30.4	14.5	5.1	15.2	1.0	0.0	15.4	1.0	0.4
A. cylindrica × *Skorospelka*	4	104.0	2.7	0.1	40.0	5.2	2.6	11.3	0.8	0.4	12.3	1.0	0.5
A. cylindrica × *F. 293*	2	109.0	—	—	26.0	—	—	10.5	—	—	14.5	—	—
A. cylindrica × *B. 1201*	8	121.7	6.4	2.3	35.1	1.7	0.6	12.3	0.8	0.3	13.6	0.5	0.2
A. cylindrica × *Etoile de Choisy*	8	104.1	7.6	2.7	17.5	19.3	6.9	11.5	0.9	0.3	13.5	4.0	1.4
A. cylindrica × *Produttore*	5	115.8	7.1	0.6	31.2	6.7	1.7	11.7	1.3	0.3	13.4	0.8	0.2
Aegilops cylindrica	20	51.3	2.6	0.3	108.2	4.8	0.9	8.6	1.2	0.2	8.1	0.5	0.1
T. aestivum (variety average)	160	90.7	15.2	4.1	8.4	5.7	0.6	9.7	1.2	0.3	18.4	1.3	0.4

Table 4

Data of the more important quantitative characteristics of the F_1 hybrids

Name of combination	D value				Length of glume			Width of glume		
	N	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	x	s	$s_{\bar{x}}$
A. cylindrica × *Bezostaya 1*	11	10.5	1.0	0.3	10.2	1.0	0.1	4.1	0.0	0.0
A. cylindrica × *Mir. 808*	8	10.2	0.2	0.8	10.1	0.7	0.1	4.0	0.0	0.0
A. cylindrica × *Skorospelka*	4	11.0	1.0	0.5	10.3	—	—	4.4	—	—
A. cylindrica × *F. 293*	2	13.8	—	—	10.1	—	—	4.0	—	—
A. cylindrica × *B. 1201*	8	11.0	1.8	0.7	10.2	0.3	0.0	4.8	0.1	0.0
A. cylindrica × *Etoile de Choisy*	8	11.7	0.9	0.1	10.2	0.2	0.0	4.0	—	—
A. cylindrica × *Produttore*	5	11.7	0.3	0.1	10.1	—	—	4.0	—	—
Aegilops cylindrica	20	9.4	1.4	0.3	10.1	1.2	0.1	3.0	0.5	0.1
T. aestivum (variety average)	160	18.9	2.6	0.5	8.1	1.9	0.4	4.5	1.8	0.3

extremely well-tillered *Aegilops* parent. Similarly the number of spikelets per spike and the width of the glume — with the exception of the *Aegilops cylindrica* Host × *B. 1201* combination — were between the similar values of the two parents.

Earliness. It has been found that the F_1 hybrids are transitional or they head at an almost identical time with the earlier parent (*Aegilops cylindrica* Host) (Table 5). The greatest deviation at this developmental phase was found among the F_1 hybrids. In regard to the time of flowering and especially at ripening an essentially smaller range of variation was observed. The flowering

Table 5

Length of growing of the F_1 hybrids of Aegilops cylindrica Host × T. aestivum L.

Combination	Number of days from sprouting*		
	Heading	Blooming	Waxen ripeness
A. cylindrica × *Bezostaya 1*	224—231	231—234	298—300
A. cylindrica × *Mir. 808*	229—231	234—235	299—301
A. cylindrica × *Skorospelka*	220—226	229—231	299—301
A. cylindrica × *F. 293*	225	231	300
A. cylindrica × *B. 1201*	225—231	229—234	298—299
A. cylindrica × *Etoile de Choisy*	220—225	225—229	299—301
A. cylindrica × *Produttore*	220—225	225—227	299—301
Aegilops cylindrica	222—227	224—227	293—295
T. aestivum (variety average)	227—236	230—233	257—264

* Sprouting occurred on October 12, 1964.

of F_1 plants occurred 4—9 days after heading. The time of the grain formation of hybrid plants was unusually long. While the generative phase averages 29 days in case of the *T. aestivum* L. varieties, the same figure was between 65 and 74 days for the *Aegilops cylindrica* Host species and the hybrids.

Disease resistance. The F_1 hybrids of the crossings of *Aegilops cylindrica* Host × *T. aestivum* L. that had been examined from this angle showed slight or strong infection with leaf rust (Table 6). Only the individuals of the *Aegilops cylindrica* Host × *Skorospelka* combinations were found to be leaf-rust resistant. With the exception of the *Aegilops cylindrica* Host × *Etoile de Choisy* and the *Produttore* combinations the resistance of the hybrids to stem rust was also satisfactory.

Table 6

Disease resistance of the F_1 hybrids of Aegilops cylindrica Host × *T. aestivum* L. (per cent)

Combination	Leaf rust					Stem rust				
	0	1	2	3	4	0	1	2	3	4
A. cylindrica × *Bezostaya 1*			73	18	9	73	27			
A. cylindrica × *Mir. 808*			25	50	25	100				
A. cylindrica × *Skorospelka*		100				75	25			
A. cylindrica × *F. 293*				100		100				
A. cylindrica × *B. 1201*		24	38	38		75	25			
A. cylindrica × *Etoile de Choisy*			38	50	12	37	38	13	12	
A. cylindrica × *Produttore*		15	50	25	10	17	25	17	16	
Aegilops cylindrica			70	30		100				

REFERENCES

DEGEN, A. (1917): A búzának egy új vadontermő fajvegyüléke (A New Wild Species of Wheat). MTA kiadványa, Budapest.

GODRON, D. (1869): Histoire des *Aegilops* hybrides. Mem. Acad. Stanislas, Nancy. 167.

KIHARA, H.—LILIENFELD, F. (1949): A New Synthetized 6× Wheat. Proc. 8th Intern. Congr. Genet. Hereditas, 307—319.

KISS, Á. (1965): A búza származása. "A búzanemesítés és -termesztés újabb eredményei" c. témadokumentáció (The Origin of Wheat. In: "Latest Results in Wheat Improving and Growing"). Orsz. Dok. Közp., Budapest. 1—9.

LELLEY, J.—RAJHÁTHY, T. (1955): A búza és nemesitése (Wheat and its Improving). Akadémiai Kiadó, Budapest. 1—544.

MCFADDEN, E. S.—SEARS, E. R. (1944): The Artificial Synthesis of *Triticum spelta*. Records Genet. Soc. A., Columbia, Missouri, **13**, 26—27.

MCFADDEN, E. S.—SEARS, E. R. (1946): The Origin of *Triticum spelta* and its Free-threshing Hexaploid Relatives. J. Hered., **37**, 107—117.

PERCIVAL, J. (1921): The Wheat Plant. Duckworth, London.

POPOVA, G. (1923): Species of *Aegilops* and their Mass Hybridization with Wheat in Turkestan. Trudi po Prikl. Bot. Gen. i. Selek. **13**, 461—482.

Priadcencu, A.—Melacrinos, A. (1957): Incruciserea indepartata factor al evolutiei organismelor (hibridul intre *Aegilops* si griu). An. Romino-Soviet, Serv. Agric., **11**, 55—80.
Rajháthy, T. (1960): Continuous Spontaneous Crosses Between *Aegilops cylindrica* and *Triticum aestivum*. Wheat Inform. Serv. Kyoto. **11**, 20.
Roemer, T. H.—Fuchs, W. H. *et al.* (1938): Die Züchtung resistenter Rassen der Kulturpflanzen. Parey, Berlin.
Stakman, E. D. (1915): Relation Between *Puccinia graminis* and Plants Highly Resistant to its Attack. J. Agr. Res., **4**, 193—200.
Tchermak, v. E. (1913): Über seltene Getreide-Bastarde. Beitr. zur Pflanzenzücht, **3**, 54.
Vavilov, N. I. (1949): The Origin, Variation, Immunity and Breeding of Cultivated Plants. Chronica Botanica, **13**, 1—364.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 161—170 (1968)

DEVELOPMENT AND GERMINATION OF THE GRAINS OF WINTER BARLEYS AS AFFECTED BY METEOROLOGICAL FACTORS

By

E. Papp

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY, TÁPIÓSZELE

In the experiment established with sowing time variations the water content of the four winter barley varieties *Lédeci Beta*, *Mezőhegyesi 68*, *Bánkúti 14* and *Jutta* gradually diminishes from milky ripeness: down from 60 to 11 per cent. At waxen ripeness the water content was 44—50 per cent. In the first period of development the dimensions of the grains are on the increase and later, after attaining the maximum gradually decrease to 20—37 per cent owing to elastic extension or contraction of the pericarp. No sooner than in the October 15 sowing did length and width reach their maximum and at the same time, before that date, maximum of length preceded that of width while in subsequent sowings it was the other way round. Thousand grain weight was highest in the case of simultaneous maximum of dimensions. The grains had germinated already in the period of milky ripeness to about 70 per cent. Germinative ability was highest at waxen ripeness, then it decreased, reaching its minimum in the period of dormancy, after maturation. Germinative faculty of the nude (prepared) grains was much higher than of grains covered by glumes.

Introduction

Several years' experiments have verified (Mándy 1965) that development and productivity of winter barley varieties are in a close correlation with the development of weather during the vegetation period. An important impact of weather conditions both on vegetative and generative development of winter barley has been demonstrated (Mándy—Kovács 1963, Mándy 1965). It seemed probable that this effect would manifest itself also in the period of grain development and influence the biological value of seed. For closer examination of the problem with several barley varieties the examinations detailed below have been conducted on the material of the winter barley ecological experiment 1964/65.

Material and Method

Examinations were conducted on four winter barley varieties: *Bánkúti 14* (B), *Jutta* (J), *Lédeci Beta* (L) and *Mezőhegyesi 68* (M). The varieties were sown manually in Tápiószele, on the trial grounds of the National Institute of Agricultural Botany in autumn 1964 on small plots of randomized layout with ten replications at 10 sowing dates of which, however, only those of uneven number were examined. The seeding dates studied were the following: I. 17 September, III. 30 September, V. 15 October, VII. 29 October, IX. 13 November.

We began to collect ears for the examinations when the grains in them had been at the end of milky ripeness (beginning of waxen ripeness). Collections were repeated every 3 or 4 days and on the same day examinations were carried out or established for germination. The grains were prepared for examinations by removing the glumes. From every seeding date and every variety 50 grains each were examined. Until full ripeness nude grains but subsequently also grains with glumes were germinated.

The month of June was somewhat cooler as compared with the average of many years and slightly poor in precipitation while July was still cooler but with substantially more rain. The main meteorological values in the period of generative development are presented in Table 1. From the data of the Table it appears that the highest heat sum manifested itself in the IIIrd, the highest mean temperature and precipitation in the VIIth seeding period.

Water content of the developing grains expressed in per cent of grain weight and the change of the shape of the grains (characterized by the dimensions of length and width or by producing drawings on a proper scale), thousand grain weight and the measure of germination were all examined.

Table 1

Weather conditions in Tápiószele during the generative developmental stage of winter barley varieties in the various seeding periods

Seeding period (1)	Seeding date (2)	Temperature sum, °C (3)	Mean temperature, °C (4)	Precipitation sum, mm (5)
I.	17. Sept.	456.0	20.8	60.5
III.	30. Sept.	542.1	20.8	61.7
V.	15. Oct.	503.1	20.9	58.4
VII.	29. Oct.	436.7	21.8	71.7
IX.	13. Nov.	357.8	21.0	14.1

Results

a) *Changes in the water content of grains.* Examinations were started on June 14 when grains in the various crops were at the end of milky ripeness or beginning of waxen ripeness. From this date measurements had been conducted every 3rd—4th day continuously until July 16 when maturation took place.

At the initial date the water content of the varieties as related to gross weight was rather important (Fig. 1), generally above 60 per cent. In every seeding period the variety *Bánkúti 14* had the lowest water content, indicating the rapid development of the variety. In various seeding periods the grain of *Lédeci Beta*, subsequently of *Jutta* exhibited the highest water content at the earlier dates. The other varieties occupied intermediary positions. As to the water content of the varieties lowest water content was found in *Jutta*, *Mezőhegyesi 68* and *Bánkúti 14* originating from the first seeding date while that of *Lédeci Beta* shifted to the second seeding date. Thus only the values of *Lédeci Beta* follow the distribution according to the scatter curve while those of the others are gradually decreasing from the first seeding date.

From June 14 the water content of the grain of every variety slantingly decreased (Fig. 2) until full maturation. Though Fig. 2 indicates the varietal means it was not necessary to illustrate separately the values (and march) of the varieties as there is no deviation — in any of them — in the change of the values.

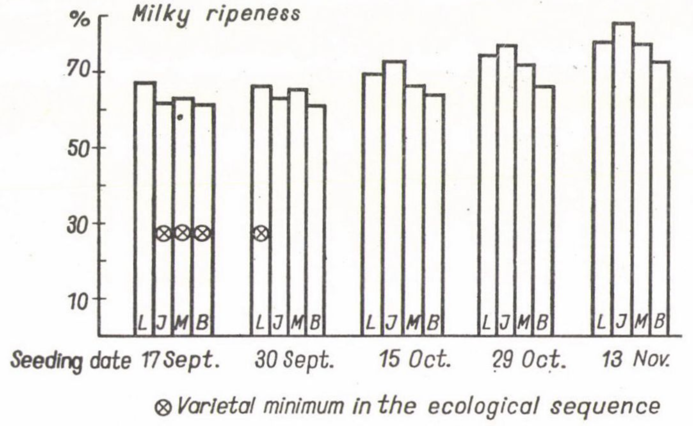


Fig. 1. Water content of grains in milky ripeness. Vertical axis indicates the water content (%), horizontal axis the ecological sequence (seeding dates). Signs: L = *Lédeci Beta*, J = *Jutta*, M = *Mezőhegyesi 68*, B = *Bánkúti 14*

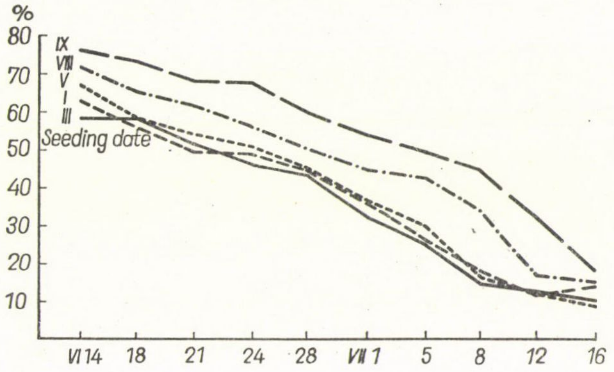


Fig. 2. Changes in the water content of grains in the various seeding periods (I, III, V, VII, IX) during the development of grains. Vertical axis indicates the per cents of water content, horizontal axis the dates of survey

According to our own and some foreign data (Kraus 1892; Brencheley 1912; Schjering 1914, etc. in Lehmann—Aichele 1931) the grains of winter barley assume the state of waxen ripeness when the water content in them reaches a value of 40 to 50 per cent. Thus, according to the authors referred to, the water content in waxen ripeness was the following: Kraus 43.1—41.4 per cent, Brencheley 43—42 per cent, Schjering 43.1—41.2 per cent. We could establish also similar values (Fig. 3) but in some cases the loss of water (condensation of the contents) within the three days was so rapid that after a high value (between 44 and 50 per cent) a result of measurement below 40 per cent followed which fell already out of the value zone of the water content of waxen ripeness established unanimously by the authors cited.

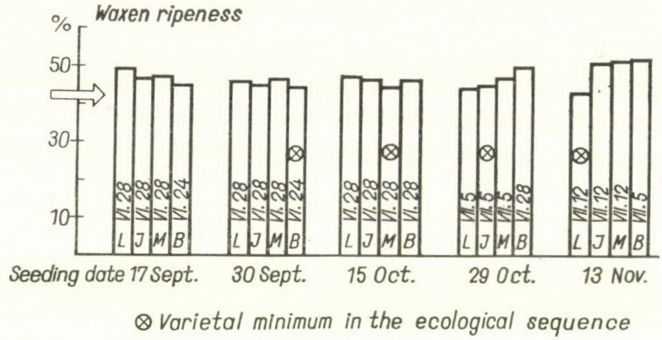


Fig. 3. Water content of grains at waxen ripeness. Vertical axis indicates the water content (%), horizontal axis the ecological sequence (seeding dates). For signs see Fig. 1. The dates inscribed in the columns indicate the time of waxen ripeness, the empty horizontal arrow the water content according to literature

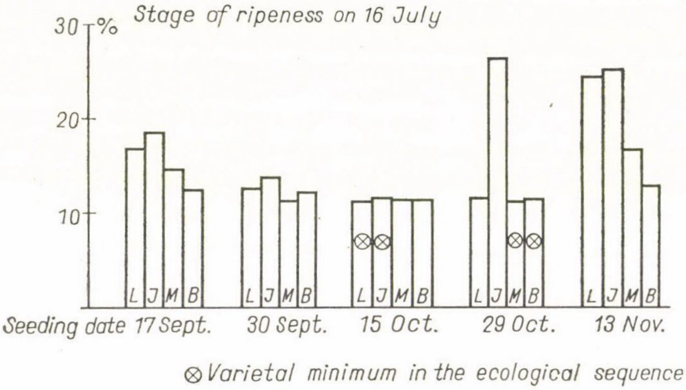


Fig. 4. Water content of grains in the period of full ripeness (July 16). Vertical axis indicates the water content (%), horizontal axis the ecological sequence (seeding dates). For signs see Fig. 1

From the data presented in Fig. 3 the values of the varieties show to be distributed according to the scatter curve in the ecological sequence established by the delayed sowing technique. The varietal minima appear, however, in different seeding periods. Thus the earliest is the water content minimum of *Bánkúti 14* (September 30 seeding) and the latest one is that of *Lédeci Beta* (November 13 seeding). The minima of the other varieties are arranged gradually between the two limits. In the earlier seedings lowest water content is that of *Bánkúti 14* while in the later ones *Mezőhegyesi 68* comes first and then *Lédeci Beta*. The varietal differences are conspicuous.

Water content measurements were closed on July 16 because the majority of varieties approached in the seeding periods the entirely mature condition. At that time water content of the varieties was for the most part near 11—13 per cent. Of course in very early and very late seedings, in several varieties this value did not appear because it could have been reached only still later. In the series of sowing time variations the distribution according to the scatter curve becomes also here manifest, the minimum being obtained in the October 15 seeding (Fig. 4). This has represented the most mature condition. To the right and to the left of this point the values of water content are on the increase. Among the varieties, *Lédeci Beta* and *Jutta* reached the varietal minimum in this seeding period while *Mezőhegyesi 68* and *Bánkúti 14* only in the October 29 seeding. In this period the prominent water content of *Jutta* was remarkable, similarly in the November 13 seeding, together with *Lédeci Beta*. The water content of *Jutta* was prominent also in the seeding of September 17. Early maturation of *Bánkúti 14* is remarkable in every seeding period.

b) *Changes in the shape of grains.* From June 14 length and cross diameter of the grains were measured generally every four day and drawings on the proper scale were prepared of their shape.

From earing until the onset of measurements relatively cool and moderately dry weather prevailed. Daily mean temperatures were generally below 18° C and there was only every 2 to 4 day some rain not exceeding 5 mm. It must be attributed to this circumstance that the development of the grains remained rather protracted particularly in the stands of the earlier seeding dates.

Examination of the change of length and width of grains in every 3 or 4 day (Table 2) reveals that on the first day of measurements (June 14) in the seeding periods of September 17 and 30 the grains attained their greatest length. This occurred on the 19th or 18th day after earing. The grains did not reach yet at that time their greatest width, this occurred only 7—10 days later when the length was already diminishing. In the October 15 seeding the maximal value both of length and width was attained simultaneously while in the later seedings the highest value of width preceded the maximum length. On the basis of the meteorological data it appears that the cooler conditions favoured more the longitudinal growth of the grains while warmer weather (above 18° C) stimulates widening.

A review of the sequence of numbers of length and width reveals that in the beginning the values increase, then attain the maximum and subsequently gradually diminish. This allows to conclude that the pericarp during the period

Table 2

Change in the dimensions of the grains during grain development with the various seeding dates. mm values are varietal means, i = quotient of length and width

Seeding date		Value of length (l) and width (w) in mm and their quotient (i) on									
		14	18	21	24	28	1	5	8	12	16
		June					July				
17. Sept.	l	*8.3*	7.9	7.7	7.2	7.2	7.2	7.0	6.8	5.5	5.3
	w	3.0	2.9	*3.5*	3.4	3.3	3.3	3.3	3.0	2.3	2.2
	i	2.7	2.7	2.2	2.1	2.1	2.1	2.1	2.2	2.4	2.4
30. Sept.	l	*8.0*	7.8	7.8	7.8	7.6	7.4	7.3	6.9	5.3	5.1
	w	2.7	2.8	3.3	*3.4*	*3.4*	*3.4*	3.0	2.9	2.3	2.2
	i	2.9	2.7	2.3	2.3	2.2	2.2	2.4	2.4	2.3	2.3
15. Oct.	l	7.7	7.8	8.0	8.4	*8.5*	7.9	7.2	7.2	5.6	5.5
	w	2.9	3.1	3.1	3.1	*3.6*	*3.6*	3.2	3.1	2.7	2.4
	i	2.6	2.5	2.5	2.4	2.3	2.2	2.2	2.3	2.1	2.3
29. Oct.	l	7.6	7.8	7.8	7.8	7.8	*8.0*	7.3	7.3	5.7	5.6
	w	2.6	3.0	3.1	*3.4*	*3.4*	*3.4*	3.3	3.2	2.6	2.3
	i	2.9	2.6	2.5	2.3	2.3	2.3	2.1	2.3	2.2	2.4
13. Nov.	l	6.3	6.6	7.2	7.6	7.6	8.1	8.1	*8.4*	6.3	5.9
	w	1.6	2.2	2.4	2.9	3.0	*3.4*	*3.4*	*3.4*	2.7	2.7
	i	3.9	3.0	3.0	2.6	2.5	2.4	2.4	2.4	2.3	2.2

of grain development can elastically follow the quantitative changes of the endosperm.

Thus during the period of milky ripening it elastically follows the swelling of the grain and subsequently, during waxen ripening it is contracting upon the reduction of volume taking place on account of condensation. Elastic contraction as to the length of grains amounts to 29—37 per cent while as to width, to 20—37 per cent. Data in literature verify elastic elongation and contraction respectively of the pericarp according to the given percentual values (SCHUMACHER 1962). In spite of the fact that the maximum dimension values in the series of seeding dates hardly change, the percentual measure of contraction from the earliest seeding gradually decreases and the smallest dimensions (length 29.8 per cent, width 20.6 per cent) can be observed after the latest seeding, probably upon ecological action.

The march of the dimensional changes of grains in the ecological sequence induced by delayed seeding technique reflects the favourable or unfavourable developments of grains. When comparing the duration of periods up to the maximum value of dimensions or to full ripeness with the thousand grain weight values (Table 3) interesting relationships are found. Also for the thousand grain weight the best values were obtained when reaching of length and width had occurred at the same rhythm and date or the maximum of width somewhat got ahead of that of the length. A major shift between the two was not favourable for thousand grain weight. This date ensued in the 5th (15. October) seeding period on the average.

Table 3

Duration of the development of grains (days) before the maximum of dimensions. $e-m$ = earing maximum and subsequently $m-r$ = maximum-ripening as well as the average thousand grain weight

Seeding dates	Grain length		Grain width		Thousand grain weight g
	$e-m$ days	$m-r$ days	$e-m$ days	$m-r$ days	
17. Sept.	19	32	26	25	44.6
30. Sept.	18	32	28	22	44.5
15. Oct.	30	18	30	18	46.6
29. Oct.	23	15	16	22	46.5
13. Nov.	28	8	21	15	43.4

From the developmental data it also appeared that for the thousand grain weight it was favourable when the developmental period had been much longer before the maximum of dimensions than subsequently. This was most favourably warranted in the October 15 seeding. Changes of the shape of grains in this favourable seeding period are presented in Fig. 5. On the change of the shape of grains information is derived also from the morphological index (x) obtained as a quotient of length and width (Table 2). — During the period of survey the index values were as a rule gradually diminishing from which it may be established that the grains are gradually turning more and more stocky.

c) *Changes in the germinative faculty of grains.* Biological value of grains is shown by their germinative faculty. We studied the developments of germinative faculty in the period of grain development and at the beginning of the dormancy of germs. From all five seeding dates samples were taken on identical days, at the earliest on 28 June and repeatedly on every 3—4 day for about a month. For germinations the grains were prepared from the spikelets and only the nude grains were placed on the germ-bed. Germination was conducted at room temperature between wetted filter paper with the usual setup.

On the day of the first germination the grains of the plants of each seeding period were in the following developmental state.

Ist seeding period. The grains were already in late waxen ripeness, on the 33rd day from earing.

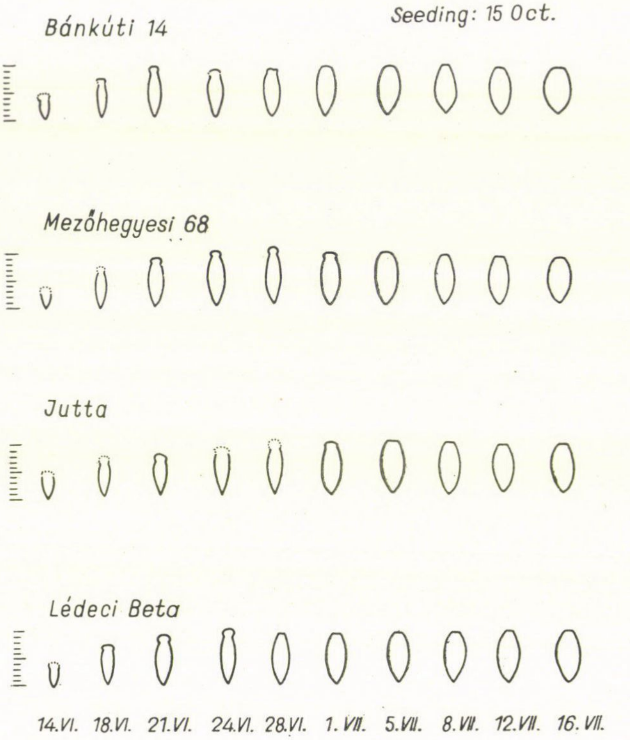


Fig. 5. Average shape of prepared grains of barley varieties examined at the dates of survey

IIIrd seeding period. The developmental stage of the grains is the same as in the Ist seeding period but the duration is 32 days.

Vth seeding period. The grains are in waxen ripeness on the 30th day from earing.

VIIth seeding period. The grains are at the end of milky ripeness, on the 22nd day from earing.

IXth seeding period. The grains are in early milky ripeness, on the 14th day from earing.

From the germination data (Table 4) it can be established that the grains germinate rather well as soon as in the very early developmental stage. The undeveloped grains of the IXth seeding period substantially germinated at the first date already (in the stage of milky ripeness), the same as a month later in completely mature condition. In most seeding periods toward maturation, apart of minor or major fluctuations, the germinative faculty is gradually decreasing or after a slight increase diminution can be observed. The fluctuations can be probably explained with meteorological factors. After July 19 the plants of the seeding periods are in completely ripe condition and the poorer germina-

Table 4

Germinative faculty of developing and developed barley grains (%)
Average values of varieties per seeding periods at the dates of sampling

Seeding period	Average of germination per cent at the following dates of survey									
	VI. 28	VII. 1	VII. 5	VII. 8	VII. 12	VII. 16	VII. 19	VII. 22	VII. 26	VII. 29
I.	90.7	90.9	84.9	88.5	93.3	91.0	88.5	84.3	73.3	84.8
III.	97.5	90.9	95.9	84.3	90.5	93.7	77.0	84.0	75.8	86.5
V.	91.7	88.2	85.9	96.0	89.2	85.5	83.0	86.5	73.8	87.5
VII.	70.6	83.2	94.2	89.3	97.5	87.8	86.0	69.3	66.3	84.3
IX.	68.3	80.9	84.2	70.3	85.3	89.5	86.8	86.8	54.0	68.3

Seeding dates: I = 17. Sept., III = 30. Sept., V = 15. Oct., VII = 29. Oct., IX = 13. Nov.

tion results obtained at that time are already due to dormancy. It is well known that winter barley has a rather long dormancy period (2—3 months) during which the germinative faculty may be strongly reduced. These germination values do not even approach as often as not the per cents recorded during the period of maturation.

Table 5

Average germinative faculty of nude (prepared) and glume-covered grains in the seeding periods (%), at maturation

Seeding date	Germinative faculty % of	
	nude grains	covered grains
17. Sept.	84.8	43.0
30. Sept.	86.5	67.0
15. Oct.	87.5	60.0
29. Oct.	84.3	33.0
13. Nov.	68.3	57.0

As referred to above, in the period of ripening and at the onset of the full ripeness stage or at the beginning of dormancy germinations were conducted with prepared, nude grains. To be able to compare germination faculty of nude and covered grains, grains with glumes that is in stage of full ripeness were also germinated. Examinations (Table 5) revealed that the germination per cents of nude grains had been substantially higher than those of grains with glumes. It is probable that the glumes contain inhibitory substances reducing the germinative faculty.

Acknowledgement

Thanks are due to the head of department, GYÖRGY MÁNDY, for his help in conduction and evaluation of examinations.

REFERENCES

LEHMANN, E.—AICHELE, F. (1931): Keimungsphysiologie der Gräser. Enke. Stuttgart. 414—415.

MÁNDY GY. (1965): Őszi árpa ökológiai kísérletek tanulságai (Results of Ecological Experiments with Winter Barley). Magyar Mezőgazdaság, **20/36,** 8—9.

MÁNDY, GY.—KOVÁCS S. (1963): Őszi árpák ökológiai vizsgálatának eredményei I. Előadás kivonat (Results of the Ecological Examination of Winter Barley Varieties. I. Abstract of a lecture). Botanikai Közlemények, **51,** 174 (1964).

SCHUMACHER, W. (1962): Physiologie. In HARDER—FIRBAS—SCHUMACHER—DENFFER: Lehrbuch d. Botanik ("Strassburger"). Fischer. Jena. 196.

Acta Agronomica Academiae Scientiarum Hungaricae 17, (1—2), pp. 171—193 (1968)

LONG-TERM EXPERIMENTS ON THE FLORA-CHANGING EFFECT OF CHEMICAL WEED KILLERS IN PLANT COMMUNITIES

By

G. UBRIZSY

RESEARCH INSTITUTE FOR PLANT PROTECTION, BUDAPEST

Research has proved the complex and significant effects of hormone-based contact and root herbicides on the transformability of anthropogenic vegetation and on the actual transformation. Such methods spread throughout the country (presently chemical weed killers are used on two million cadastral acres of land) to newer areas and cultures (such as rice fields, vegetable gardens, etc.) will bring about the complete transformation of the weed flora of Hungarian arable land, primarily of the obligate and archeophyton weeds. Not only the modification of the weed flora but that of the weed communities can be expected. In waste-ground the succession can be speeded up and the value of the plant stock can be increased by artificial intervention, i. e. by the spread of *Gramineae*. The change in vegetation effected by chemical weed killers is most intensive in the pastures. From a practical viewpoint, however, it is useful because the great increase of forage grasses goes together with the destruction of harmful weeds. The experiments conducted show that weed control can nowadays be treated on the level of communities only and when deciding to eradicate the weeds in an area we combat the entire weed community not just the weeds of a single culture during one season. We fight against them in every culture making the extremely radical chemical methods feasible at all. I am convinced that in the applied phyto-sociology of communities, the communities themselves should be studied in addition to the areal examinations concerning forestation which is in general the most helpful for applied agriculture.

Introduction

Today the majority of researchers studying plant communities (KNAPP 1948—49, KNAPP 1952, REDEMACHER 1956, ELLENBERG *et al.* 1950, etc.) do not treat cultivated plants and weeds separately, in a loose relation and weeds as concurrents only. When taking up the struggle against the weeds of a particular area, modern applied agrotechnology cannot only attempt to suppress certain aggressive weed species through this phytological approach to communities, but with the aid of studies of the environment it has to realize, first of all, the actual agrophyto-sociology of the area, its aspects, consociations, entire dynamics, evolved as a result of crop rotation and other anthropogenic influences. Thus must be prepared protection against agrophyto-sociology in all its aspects. The role and status of both the individual weeds and their populations, the over-running of plough- and fallow land not under cultivation and of places with ruderal vegetation or the areas otherwise utilized must be examined in reference to the weed vegetation taken as a whole. Thus in reference to this problem agricultural botany is overlapping botany, especially geobotany.

First RADEMACHER (1948) called attention to the fact that weed research is a synthetic problem. The phyto-sociological approach was worked out mainly by ELLENBERG (1950), R.–G. KNAPP (1952), JAHN (1952) and RICHTER (1956) while in HUNGARY the studies of ÚJVÁROSI (1945–1965), TIMÁR (1949–56) and UBRIZSY (1948–1965) should be considered fundamental in the field. Their studies on one hand cover the entire area of the country, while on the other they treat the constant examinations carried out in a particular area over a period of several years.

As early as 1947 RADEMACHER had emphasized the effect of crop rotation and intensive mechanized agrotechniques on the modification and thinning of vegetation. This transformation has been even more extensive since chemization (e.g., fertilizers, leaf and spray fertilizers, insecticides etc.) due to the large-scale development of organic chemistry began a thriving development along with the mechanization of agricultural production. In the chemization of agriculture chemical weed killing (i.e., the use of the different leaf and root herbicides) is of the greatest importance for the study of weeds. Our research has been done continuously in experimental fields used in the country. The experiments have been carried out on plots divided into one cadastral acre treated with herbicides, cultivated only by the the classical agrotechnical methods, i.e., without herbicides. There we could continually observe the transformation of the weed flora under radical effects, i.e., we could examine the effect of biological stress of very aggressive bio-active herbicides on the weed community as a whole.

Materials and Methods

Between 1953 and 1965 we paid special attention to the influence of chemical weed killing on certain weed communities. We not only studied the individual sensitivity or resistance, but also the changes experienced by the weed flora and communities in ploughland (on cereals and row crops) pastures and in waste-ground covered with ruderal weeds if an extremely intensive or radical chemical intervention (biological stress) affects them throughout a longer or shorter time span.

Permanent experiments have been carried out on two experimental fields. Thus we employed the Hungarian-produced 2,4-D *(Dikonirt)* and MCPA *(Nikrezil paste)* type sprays on the cereals of the tested tillage areas (Budakalász and Keszthely in 1953–1957 and 1963–65 respectively) while on row crops (maize fields) atrasine, a product containing aminochlortriazine (5–6 kg/ca) or rather the Hungazine PK have been used since 1960 (see Table 1). In the first year, 1953, the area was not yet subjected to chemical weed killers. From 1954 chemical weed killers have been applied on cereals every year while on the maize crops only twice (1955, 1957) but regularly since 1960. The table shows from the respective years, the behaviour or mass reaction of 25 most important constant dominant species of the *Consolido-Stachyetum annuae* association (UBRIZSY 1954, 1955) taken from the check areas not sprayed in the particular year (UBRIZSY 1958). The post effect of chemical weed killing was studied in the following year always in the areas kept as controls. Spraying was administered at the usual time (end of April — beginning of May) when cereal crops reached 15–25 cm in height while a pre-emergence spray was used on maize in April. The following conclusions can be drawn especially from the permanent tests of the last eight years (1957—1965): 1) the composition of the weed community and its character have not essentially changed under the influence of chemical weed killing over the years, only the abundance—dominance (A—D) values have been reduced, i.e., the weed cover of the area has which may be related to the gradual reduction of the weed-seed content of the soil. A part of the more sensitive species has disappeared or reduced; among these were characteristic species too. Thus the weed community is rather qualitatively modified because the great weed seed supply of the soil has assured a certain level of weed growth for many years.

The agrophyto-sociology of the communities has been fully studied. It is striking that the composition of the early spring hivernal therophytomer *Veronica hederifolia—Veronica polita* aspect (Ubrizsy 1955) did not alter at all and moreover its facies values also remained unchanged. This can be attributed to the fact that chemical weed killing affects the cereal crops at a time when this aspect has generally developed seeds and thus its yield cannot be affected. Besides destroying or checking the perennial weeds in the cereal crops the actual purpose of chemical weed killing is the destruction of the early summer aspect (in the particular area this is the *Consolida regalis—Raphanus raphanistrum* aspect) which is primarily responsible for the infestation of cereal crops. The stubble-type weeds (in our area *Setaria viridis—Ajuga chamaepitys*) which for the most part are composed of thermophile species of Mediterranean origin could not be eradicated by chemical means from the cereals because at the time of spraying this aspect can hardly be found even in seedling stage. The stubble aspect reaches full growth actually in the summer row crops (potatoes, maize, sugar beets, etc.) in addition to the stubble of cereal crops. Therefore the weed facies of this aspect can be reduced only by methodical spraying with chemicals of row crops all the more that chlortriazine derivatives when used on maize and potato make it possible as they possess a long-lasting effect and can be extensively applied. Researchers on weed communities have recognized that in a particular area a full weed community can be forced to retreat by chemical weed killers only if these affect all the weed aspects or rather consociations. The early spring weed aspect can be checked at most by spraying the autumn stubble (when solutions of even stronger concentration can be used) or before the autumn sowing (autumn application of aminochlortriazines). It must be pointed out that chemical weed killers cannot be expected to produce miracles in reducing the weed cover although a reduction has occurred throughout the country during the last ten years. It has to be applied just as regularly as any other agrotechnical method. According to Balogh (1953) one preserves the equilibrium of agrobiological communities by regular intervention. If this balance due to the lessened intensity of these interventions (e.g., agrotechniques) becomes upset then regeneration begins to take place at full speed. Chemical weed killing is a radical factor and its effect on the quantitative composition of the community can be immediately noted and maintained only if this additional influence is constantly repeated. As a chemical process, chemical weed killing is just as an integral part of modern agrotechniques as any more recent cultivating machine.

The weed consociations of row cultures can be most easily influenced by chemical means at the maize phase of crop rotation, for maize crops are the least sensitive and spraying may take place presowing in autumn or in spring before emergence or — as an addition — post-emergence. In the latter case the stubble phase can be found as a soil synusium during the early summer phase already (especially during the seedling phase) which stubble phase will be more and more quickly spreading after early hoeing as to supplant the early spring aspect destroyed is the result of hoeing. If we want to assure the better sprouting and initial growth of maize crops, then pre-emergence spraying is more effective than treatment with Atrazine or Dikonirt. In this way the early summer aspect is destroyed at its initial stage of growth. The second spraying, on the other hand, reduces or destroys the consociation composed of thermophile species and reaching its full growth in midsummer.

Results

An examination of the 25 most important constant dominant weed species has revealed the following changes brought about by chemical weed killing during the permanent examinations carried out for five years. The weed cover as well as the weed seed percentage of both the soils and the crops have been reduced. This decrease can be equally observed in the cereal and row

Table 1

Scheme of herbicide rotation for ploughland

Type of plants	Herbicide	Type of effect	Time of application	Length of effectiveness	After- and secondary effects
Winter cereal wheat	2,4-D (e.g., Dikonirt)	hormone-type leaf herbicide	Spring (post-emerg.)	appr. 2 months	None
Maize	Aminochlortriazine (e.g., Hungazine PK)	root herbicide	Autumn or spring (pre-sowing or pre-emerg.)	Depending on dosage 8—36 months	Serious effect on cereals
Maize	Hungazine PK + Dikonirt	leaf + root herbicide	Spring (pre-emerg.)	6—8 months	slight (on winter cereals?)
Spring cereal (barley)	MCPA (Dicotex) or DNOC (Krezonite-E)	hormone-type or contact leaf herbicide	Spring (post-emerg.)	1.5— 2 months	None
Potatoes	Prometryn (A 1114 Merkazine or Aresine	root herbicide	Spring (pre-emerg.)	2—3 months	None
Peas	DNBP (Sevtox) or Aretite	contact leaf herbicide	Spring (post-emerg.)	1.5—2 months	None

crops, the exception being the early spring aspect which attacked with the same strength but has no effect on the yield. In addition to the reduction of A—D values that of the number of species is also significant because of selection.

In early row crops (linen, onion, peas, etc.) the early spring aspect has been destroyed by planting operations or survives only in part and thus it has no significance. The dominant weed aspect is the same as that of the cereal crops (in the examined areas *Consolida regalis* — *Raphanus raphanistrum*) therefore chemical weed killing must attempt to eliminate this aspect and it must be sprayed at approximately the same time as the cereals (end of April, beginning of May), i.e., when the dominant species of this aspect are at the initial, biologically speaking sensitive, stage of development.

A much more important problem is the development of a homogeneous resistant weed flora in our tillage and vineyards due to the monocultural production of maize or rather to spraying with aminochlortriazine for several years. These weed species are: *Convolvulus arvensis*, *Equisetum arvense*, *Lathyrus tuberosus*, *Rubus caesius v. agrestis*, *Cynodon dactylon*, *Echinochloa crus galli*, *Setaria* species etc. Therefore there is an increasing need for the introduction of herbicide rotation in the given areas (see Tables 1 and 2). This was already suggested by HARPER (1957) in order to avoid the substitution of sensitive members of the earlier mixed weed flora by resistant weed species or the development of tolerant or resistant ecotypes instead. He also suggested keeping the weed cultures of the waste-grounds as genetic buffers. In order to avoid the danger of the development of resistant biotypes, combinations of herbicides should be used, viz. the simultaneous application of herbicides with different structures and the preference for chemicals that take a speedy effect (herbicides having a greater and more perfect influence on soil sterilization). The two introduced herbicidal rotation schemes presented in the tables offer a chance to avoid both in tillage and vineyards the development of hormone and triazine resistant weed flora.

The task is much more complicated in diverse agrophyto communities which are more natural in origin. The reduction of species due to chemical weed killing as well as the composition of the cover are the most striking in pastures where, in comparison to the segetal crops, stands are richer, thicker and more resistant. When discussing man's intervention in nature only chemical weed killing has a role identical with the burning of forests for modifying vegetation. So the greatest attention has been paid to this question. In Hungary most of pastures are entirely neglected and hardly suitable for grazing. Generally 50—80 per cent of the areas is over-run by weeds and approximately half of the fodder utilized for grazing here is weed, part of which is not even fed by grazing animals. Then there is urgent need of making our pastures over-run with *Ononis spinosa*, *Eryngium campestre*, *Carduus*, *Cirsium*, *Juncus*,

Table 2

Herbicide rotation in vineyards

Culture	Herbicide	Type of effect	Time of application	Length of effectiveness	Secondary effects on weeds
Vineyard nursery	Aresine	root herbicide	Spring (post-emerg.)	3— 4 months	None
Vineyard Mother Colony	Hungazine PK (large dosage)	root herbicide	Autumn or spring (pre-emerg.)	8—36 months	Produces resistant weed flora
Young vineyard	Aresine	root herbicide	Spring (post-emerg.)	3— 4 months	None
Producing vineyard (older than 4 yrs)	Hungazine PK	root herbicide	Autumn (before covering)	8—36 months	Resistance
	Domatol (Simazine + ATA)	root herbicide + contact herbicide	Spring (post-emerg.)	6— 8 months	Resistance ?
	Primatol D (Atrazine + MCPA + 2,4,5-T)	root and leaf herbicide	Beginning of summer (post-emerg.) should not reach leaves	4— 6 months	None
	2,4,5- Tethanol	leaf herbicide	should not reach leaves	3-- 4 months	None

Carex, etc. species suitable for grazing. Chemical weed killing in itself cannot be regarded as a final solution for chemical weed killing — as RICHTER (1957) also points out in his pertinent and extremely valuable study — that can be only one of the factors in the amelioration of meadows and pastures since this must be done in conjunction with projects such as fertilization, regional organization, etc.

The problem of chemical weed killing in pastures has always been important for Hungarian research. Long-term experiments have been conducted on the public pastures of Keszthely—Gyenesdiás as well as in other areas since 1954 (e.g., Budakalász, Makád, Apajpuszta, etc.). In four years the over-run pasture of Keszthely was thoroughly transformed due to the effect of chemical weed killing. The herbicides used were as follows: 2 kg Dikonirt (2,4-D Na salt) + + 0.25 kg moistener (Mavepon, Sandovit etc.), 2.5 lt. Dikamin, 1.5 kg M 52 (MCPA), 2 or 3 lt Tributon (2,4-D + 2,4,5-T ester), Tormona 80 (2,4,5-T amylester) and Trifenox 80 (2,4,5-T ester), in a 0.8 l/ca dosage in the spring or a Dikonirt spray twice a year with 250 lt water per ca. The individual plots were 1 cad. acre in size and they were sprayed yearly at the same time with identical preparations (UBRIZSY 1957).

The first spraying occurred before the first heading or rather before the first flowering of the grasses, i.e., in May during the early summer aspect. The time of the second weed killing is the second heading, i.e., the second flowering of the grasses during the summer aspect. The total plant cover of the grazing area did not change in Keszthely under the effect of spraying: it remained 100 per cent but the original 50—60 per cent weed facies reduced to 20—25 per cent after the first year of spraying, to 5—6 per cent in the second year and in the third year to 0—2 per cent. The number of species in the botanical composition was altered as follows: before treatment there were 42 species, after the first year of spraying the number dropped to 32, in the second year to 22, in the third year to 12 and in the fourth year it reached 12. This reduction was primarily evident among the filling and weed plants. The proportion of lawn grass to *Papilionaceae* has changed too. In the original stock it was 20 : 18, in the first year it became 38 : 23, in the second 60 : 23, in the third 71 : 23 and in the fourth year it became 88 : 12 which implies that under the influence of chemical sprays weeds of pastures considerably grew not only at the expense of the destroyed weeds, but to a relative degree at the expense of *Papilionaceae* too (Fig. 1).

The studies recording the changes taking place in the fauna of pastures subject to regular chemical treatment are very important. JERMY—SÁRINGER (1960) have regularly collected — by using the sweeping method — the fauna combinations from the untreated pastures or areas sprayed with herbicides (Dikonirt) and analyzed them. Just as the botanical composition changed under the effect of herbicides in favour of the *Gramineae*, the number of

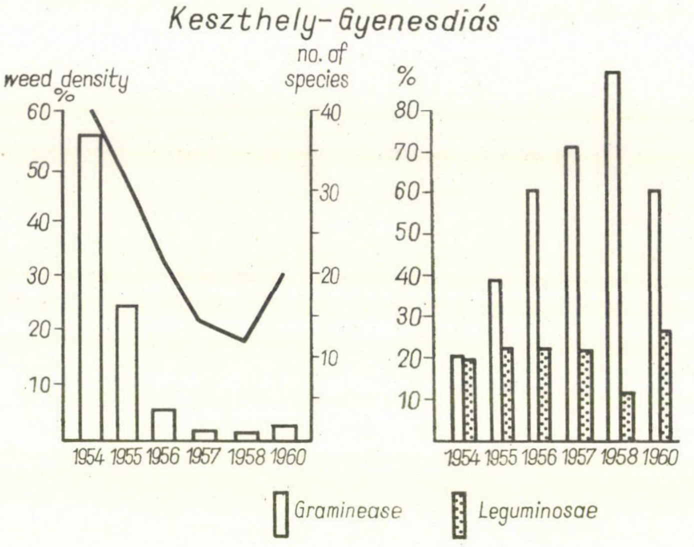


Fig. 1. Changes in the weed density and number of species in the Keszthely — Gyenesdiás pasture as the result of herbicide treatment

Orthopterae*, *Homopterae **(mainly the cicada) and other animals living on lawn grasses increased: simultaneously the proportion of *Hymenopterae* and *Coleopterae* reduced showing that the continuously flowering Dicotyledons almost vanished. The material was collected with 10×10 sweeper and showed the following distribution:**

Orthoptera	sprayed	140
	control	56
Homoptera	sprayed	1527
	control	757
Hymenoptera	sprayed	118
	control	312
Coleoptera	sprayed	17
	control	86

These accurately reflect the biochanges in the community which are — however — not harmful to the economic objective: to hay yield.

These examinations carried on for several years can prove that the pasture over-run by *Ononis spinosa*, one of the most stubborn weeds, can be cleared by methodical chemical control if done continually through years and at cycles harmonizing with the rhythm of vegetation. It is undoubtedly the plant stock of diverse botanical composition in pasture that chemical weed killing has the greatest transforming effect on, for not only the species are essentially reduced but its structure does change as well: the major part of the dicotyledonous plants forming the aspect will also disappear. From a practical viewpoint this

drastic structural change in the community is only too useful and desirable because the hay yield from pastures undergoes a sudden change by increasing, treble or quadruple the original yield. However, it must be emphasized that this change is not a final one. As soon as spraying with herbicides is discontinued certain perennial (geophytonous and hemicryptophytonous) weeds emerge again. This actually means that chemical sprays must be just as permanently used along with other methods of cultivation as any other agrotechnical procedure in the pastures. Wherever chemical weed killing is interrupted after 1 or 2 years of treatment first the perennials (with competitive root systems) begin to grow. Lasting results can be assured by at least 2—3 years of thorough spraying (twice a year).

We have also examined the effect of different contact and systemic herbicides in transforming the flora or rather in promoting grass growth on the over-grown grass cover of the sodic Solontsak-type pastures of Apajpuszta which had not been used for grazing and were otherwise undisturbed. The experiments, now in their fifth year, have resulted in a few conclusions of practical value. First of all, the most widespread and dangerous weed of the Solontsak sodic pastures of the Danube—Tisza Midregion, *Lepidium cartilagineum*, can be vigorously restricted by continued spraying and after years it can even be eradicated. The growth of *Statice (Limonium) gmelini*, *Aster pannonicus*, *Artemisia monogyna*, *Scorzonera*, *Taraxacum*, *Cerastium*, etc. species can also be checked and by two years of regular spraying (twice a year) they can be perfectly destroyed. Under the influence of the second year of spraying the otherwise frequent and numerous *Ceratodon purpureus* has also disappeared. On the other hand *Nostoc commune* cannot essentially be reduced if there are grass-free, bare patches of soil in the lawn. The sedge and reed species very resistant to herbicides *(Heleocharis palustris*, *Carex stenophylla*, *C. nitida etc.)* can only be moderately controlled because of their morphological character.

It must be emphasized that under the influence of spraying the dicotyledonous weeds and filling plants either die out or become very restricted and in their place the best grasses of the acidic pasture flourish, i.e., mainly the very valuable quickly tillering *Puccinellia distans* et v. *limosa*.

In 1960, after two years the effect of herbicides, especially that of the best UT-10 MCPA preparation on the grass cover was still striking. Neither the number of species increased essentially (from 12 to 13) nor the weed cover changed (4—6 per cent) but *Puccinellia distans* covered at least 80 per cent of the area with its excellent, well-grown grass. Only 1 or 2 plants of *Lepidium cartilagineum* could be found per square meter in contrast to the 550 plants found over an equal area in the control plots. Almost equally good results were achieved by the Dicophag MCP ester, the combination of Dikonirt + Nikrezil paste and Dikonirt. In sodic areas where the useful, sensitive *Papilionaceae* rarely grows and where the valuable fodder is produced exclusively by lawn

Table 3

Changes in the vegetation of the Keszthely—Gyenesdiás

List of species		Control		2,4-D 2 kg/kh once yearly		2,4-D 1.5 kg/kh twice yearly	
		1957	1965	1958	1965	1958	1965
Total plant density in %		100	100	100	100	100	100
Weed density in %		50—60	40	20—25	25—30	6—8	20—25
Ratio of *Gramineae* : *Leguminosae*		20 : 18	20 : 18	47 : 15	75 : 27	38 : 23	75 : 22
Cp. H.	*Agrostis alba*	1	1—2	1	1—2	1	1—2
Eua. H.	*Andropogon ischaemum*	+—1	+	+	+	+	+
Me. H.	*Arrhenatherum elatius*	+	+—1	+	+	+	+
Kozm. G.	*Cynodon dactylon*	2	2	2	2	2—3	3
Eu. H.	*Cynosurus cristatus*	+—1	+—1	+—1	+—1	+—1	+—1
Eua. H.	*Dactylis glomerata*	+	+	+	+	+	+—1
Kozm. H.	*Deschampsia caespitosa*	+	+	+	—	+	—
Eua. H.	*Festuca pratensis*	1	+—1	1	1	+—1	+—1
Cp. H.	*Festuca rubra*	1—2	2	2	2	2	2—3
Eu. H.	*Lolium perenne*	+—1	+—1	+—1	1	1	1—2
Eua. H.	*Carex distans*	1—2	1—2	1	1	+—1	1
Eua. Th. (-TH)	*Cyperus fuscus*	+	+	+	+	+	—
Cp. H.	*Juncus articulatus*	+	+—1	+	+	+	+—1
Kozm. Th.	*Juncus bufonius*	+	+—1	+	+	+	—
Eua. H.	*Juncus conglomeratus*	+	1	+—1	+—1	+—1	1
Cp. H.	*Juncus effusus*	+	—	+	+	—	—
Kozm. Th.	*Polygonum aviculare*	+	+	+	—	—	—
Kozm. Th.	*Polygonum lapathifolium*	+	+	+	—	—	—
Kozm. H.-TH.	*Cerastium caespitosum*	+	+	+	+	+	—
Cp. H.	*Sagina procumbens*	+	+	+	+	—	—
Eua. H.	*Gypsophila muralis*	+	+	+	—	—	—
Eua. H.	*Ranunculus acer*	+—1	+	+	+	+—1	+
Eu. Th.-TH.	*Ranunculus Sardous*	+	+	+	+	+	+
Kont. H.	*Potentilla arenaria*	+	+	—	—	—	—
Eua. H.	*Lotus corniculatus*	1—2	1	1	1	1	+—1
Eua. H.	*Medicago falcata*	+	—	+	+	—	—
Eua. H.	*Medicago lupulina*	+	+	—	+	—	—
Me. H.	*Ononis spinosa*	3	2—3	+—1	1	1—2	1—2
Eu. Th.-TH.	*Trifolium campestre*	+	+	—	—	—	—
Eua. H.	*Trifolium fragiferum*	1—2	1—2	1	1—2	1	1—2
Eua. H.	*Trifolium pratense*	+—1	+—1	+	+	+	+
Eua. H.	*Trifolium repens*	1	1—2	1	1—2	1	1
Eu. Th.	*Linum catharticum*	+—1	+—1	+	+	—	+
Kozm. H. G.	*Euphorbia cyparissias*	+	+	+	+	+	—

pasture as the result of chemical weed killing

MCPA 1.5 kg/kh		Tributon 3 lit/kh		2,4.5-Tormona/0.8 kg/kh		2,4.5-T Trifenox/0.8 kg /kh		2,4-D-amin 2.5 kg/kh	
1958	1965	1958	1965	1958	1965	1960	1965	1958	1965
100	100	100	100	100	100	100	100	100	100
4–5	12	8–10	10–12	3–4	6	4–6	8	5–6	15
65 : 25	60 : 23	44 : 8	66 : 9	50 : 13	54 : 23	48 : 13	50 : 15	68 : 26	37 : 15
1	1–2	1	1–2	1–2	2	1–2	2	1–2	2
+	+	+	+	+	+	+	+	+	+
+	+–1	+	+	+	+	+	+	+	+
2–3	2–3	2	2–3	2–3	2–3	2–3	2–3	2–3	2–3
+–1	1	+–1	+–1	+–1	+–1	+–1	+–1	+–1	+–1
+	+	+	+	+	+(0)	+	+(0)	+	+
+	–	–	–	–	–	–	–	+	–
+–1	+–1	+–1	+–1	+–1	1	+–1	1	1	1
2–3	3	1–2	2	1–2	2	2–3	2	2–3	2–3
1	+–1	+–1	+–1	+–1	1	+–1	1	+–1	+–1
+–1	+–1	+–1	+–1	+	+–1	+	+–1	1	1
–	–	–	–	–	–	–	–	–	–
+	+	+	+	+	+	+	+	+	+
+	–	–	–	–	–	–	–	+	–
+–1	1	+	+–1	+	+–1	+	+–1	+–1	+–1
–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–
+	–	–	–	–	–	–	–	+	–
–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–
–	–	+	+	–	–	–	–	+	+
–	–	–	–	–	+	–	+	+	–
–	–	–	–	–	–	–	–	–	–
+–1	2	+–1	+–1	1	1–2	1	1–2	1	+–1
–	–	–	–	–	–	–	–	–	–
–	+	–	–	–	–	–	–	–	+
+–1	+–1	–	+	–	–(+)	–	–(+)	+–1	+–1
+	+–1	–	–	–	–	–	–	–	–
1	1–2	+–1	+–1	+–1	1	+–1	1	+–1	+–1
+	+–1	–	+	–	+	–	+	+	+
1	1–2	+–1	+–1	1	1–2	1	1–2	1	1
–	+	–	+	–	–	–	–	+	+
+	–	–	–	–	–	–	–	+	–

Table 3

	List of species	Control		2,4-D 2 kg/kh once yearly		2,4-D 1.5 kg/kh twice yearly	
		1957	1965	1958	1965	1958	1965
	Total plant density in %	100	100	100	100	100	100
	Weed density in %	50–60	40	20–25	25–30	6–8	20–25
	Ratio of *Gramineae*: *Leguminosae*	20 : 18	20 : 18	47 : 15	75 : 27	38 : 23	75 : 22
Eua.-K. H.-Ch.	*Polygala comosa*	+	+	+	–	+	–
Pont.-Med.-Th.	*Lythrum tribracteatum*	+	+	–	–	–	–
Pont.-Med.- H.	*Eryngium campestre*	+–1	+–1	+	+	+	+
Kozm. Th.	*Anagallis arvensis*	+	+	–	–	–	–
Eu. Th.-TH.	*Centaurium umbellatum*	+	+	+	+	–	+
Kozm. H. G.	*Convolvulus arvensis*	+	–	–	–	–	–
Med. H.	*Mentha pulegium*	+–1	+–1	+	–	–	–
Med. H.	*Prunella laciniata*	+–1	+–1	+	+	+	+–1
Kozm. H.	*Prunella vulgaris*	+–1	+	+	+	+	–
Eu.-Kont. Ch.	*Thymus serpyllum*	+	+	–	–	–	–
Eua. H.	*Galium mollugo*	+	–	+	–	+	–
Eua.-Kont. H.	*Galium verum*	+–1	+–1	+	+	+	+
Eua. H.	*Plantago maior*	+	+	–	–	–	–
Kozm. H.	*Plantago lanceolata*	+–1	1	+	+	+	+–1
Kozm. H.	*Achillea collina*	1–2	1–2	+–1	+–1	+–1	1
Adv. Th.	*Ambrosia elatior*	+	+	–	–	–	–
Eu. H.	*Bellis perennis*	1	+–1	+–1	+–1	+–1	+–1
Me. H.	*Centaurea pannonica*	2	1–2	+–1	+–1	+–1	+–1
Eua. H.	*Cichorium intybus*	+–1	+–1	+	+	+	+
Eua. H.	*Leontodon autumnalis*	3	2	1	1	1	+–1
Eua. H.	*Leontodon danubialis*	+	+	–	+	–	–
Eu. H.	*Hieracium pilosella*	+–1	+–1	–	+	+	+
Eua. H.	*Senecio Jakobaea*	+	+	–	–	–	–
Kozm. H.	*Taraxacum officinale*	+–1	+	+	+	+	+
Accessor:							
	Hypnum cupressiforme	+	+	+	+	+	+
	Thuidium abietinum	+	+	–	–	–	–
	Bovista plumbea	+	+	+	+	+	+
	Coprinus ephemerus	+	+	–	+	–	–
	Galera tenera	+	+	+	+	+	+
	Marasmius oreades	+–1	+	+	+	–	–
	No. of species	58	55	45	42	39	32

(continued)

MCPA 1.5 kg/kh		Tributon 3 lit/kh		2,4.5-T Tormona/0.8 kg/kh		2,4.5-T Trifenox/0.8 kg/kh		2,4-D-amin 2.5 kg/kh	
1958	1965	1958	1965	1958	1965	1960	1965	1958	1965
100	100	100	100	100	100	100	100	100	100
4–5	12	8–10	10–12	3–4	6	4–6	8	5—6	15
65 : 25	60 : 23	44 : 8	66 : 9	50 : 13	54 : 23	48 : 13	50 : 15	68 : 26	37 : 15
+	—	—	—	—	—	—	—	+	—
+	—	—	—	—	—	—	—	—	—
+	+	—	—	—	—	—	—	+	—
—	—	—	—	—	—	—	—	—	—
+	+	—	—	—	—	—	—	+	+
—	—	—	—	—	—	—	—	—	—
+	—	—	—	—	—	—	—	+	—
+	+	+	+	+	+	+	+	+	+
+	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
+	—	—	—	—	—	—	—	—	—
+	+	—	—	—	—	—	—	+	+
—	—	—	—	—	—	—	—	—	—
+	+	—	—	—	—	—	—	+	+
+	+	+	+	+	+	+	+	+—1	+—1
—	—	—	—	—	—	—	—	—	—
+—1	+—1	+	+—1	—	+	—	+	+—1	+—1
+—1	+—1	+	+	—	+	—	+	+—1	+—1
—	—	—	—	—	—	—	—	—	+
+—1	+—1	+	+—1	+	+	+	+	1	+—1
—	—	—	—	—	—	—	—	—	+
+	+	—	+	—	—	—	—	+	+
—	—	—	—	—	—	—	—	—	—
—	+	—	—	—	—	—	—	—	+
+	—	+	+	+	+	+	+	+	+
—	—	—	—	—	—	—	—	—	—
+	+	+	+	+	+	+	+	+	+
—	—	—	—	—	—	—	—	—	—
+	+	+	+	+	+	+	+	+	+
—	+—1	—	—	—	—	—	—	—	+
37	31	21	25	18	21	18	22	36	32

grasses, chemical weed killing has very powerful and lasting results in a short time. The introduction of chemical weed killing with preparations containing MCPA can everywhere be suggested on our Solontsak-type acidic areas (Fig. 2).

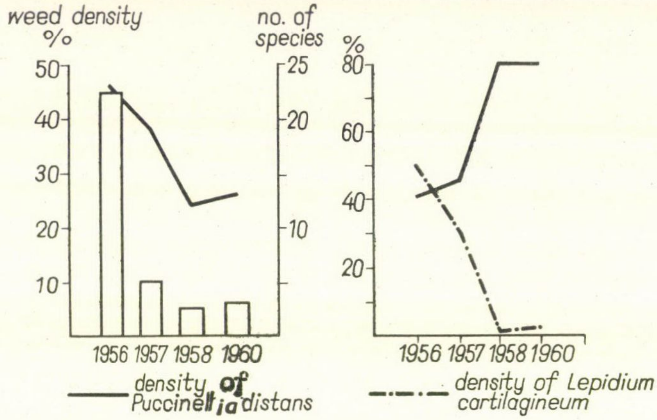


Fig. 2. Changes in weed density and number of species in acidic meadows due to herbicide treatment

The widespread introduction of aminochlortriazine resulted in an almost immediate dramatic transformation of weed flora. The root herbicides with quite lasting (residual) and extremely broad biological effects have perfectly selected the original weed populations in favour of the tolerant or resistant populations if used regularly through 3 to 4 years in increased dosage (e.g., 6—9 kg per cadastral acre) in the same area (e.g., in a maize monoculture, in vineyards, orchards). Thus mainly in maize but sometimes in vineyards the initial weed association, the *Amarantho—Chenopodietum* (with subassociation: eragrostidetosum in sand, convolvuletosum in more heavy soils, together with typicum etc.) which can be easily controlled by common and mechanical or chemical means has been transformed into an *Echinochloa — Amaranthetum* or in vineyards into a typical *Convolvulo—Portulacetum.* Especially atrazine (Hungazin PK) had a radical effect in this case. In the vineyards the mixed weed populations in which *Convolvulus arvensis* amounted to 10 per cent and *Portulaca oleracea* to 2–3 per cent such as in the Vértes Mountains or in the Mór wine district have been reduced by triazine and in their place the triazine-resistant and, tolerant *Convolvulo—Portulacetum* has grown in which *Convolvulus* amounted to 80 per cent and *Portulaca* to 10–15 per cent (Kiss 1964, Ubrizsy 1963, 1966).

The formation of the segetal weed vegetation of Hungarian vineyards (culture succession) under the effect of herbicide treatments or increased mechanical effects is represented by the succession scheme according to different soil types and regions (Ubrizsy 1966), (Fig. 3).

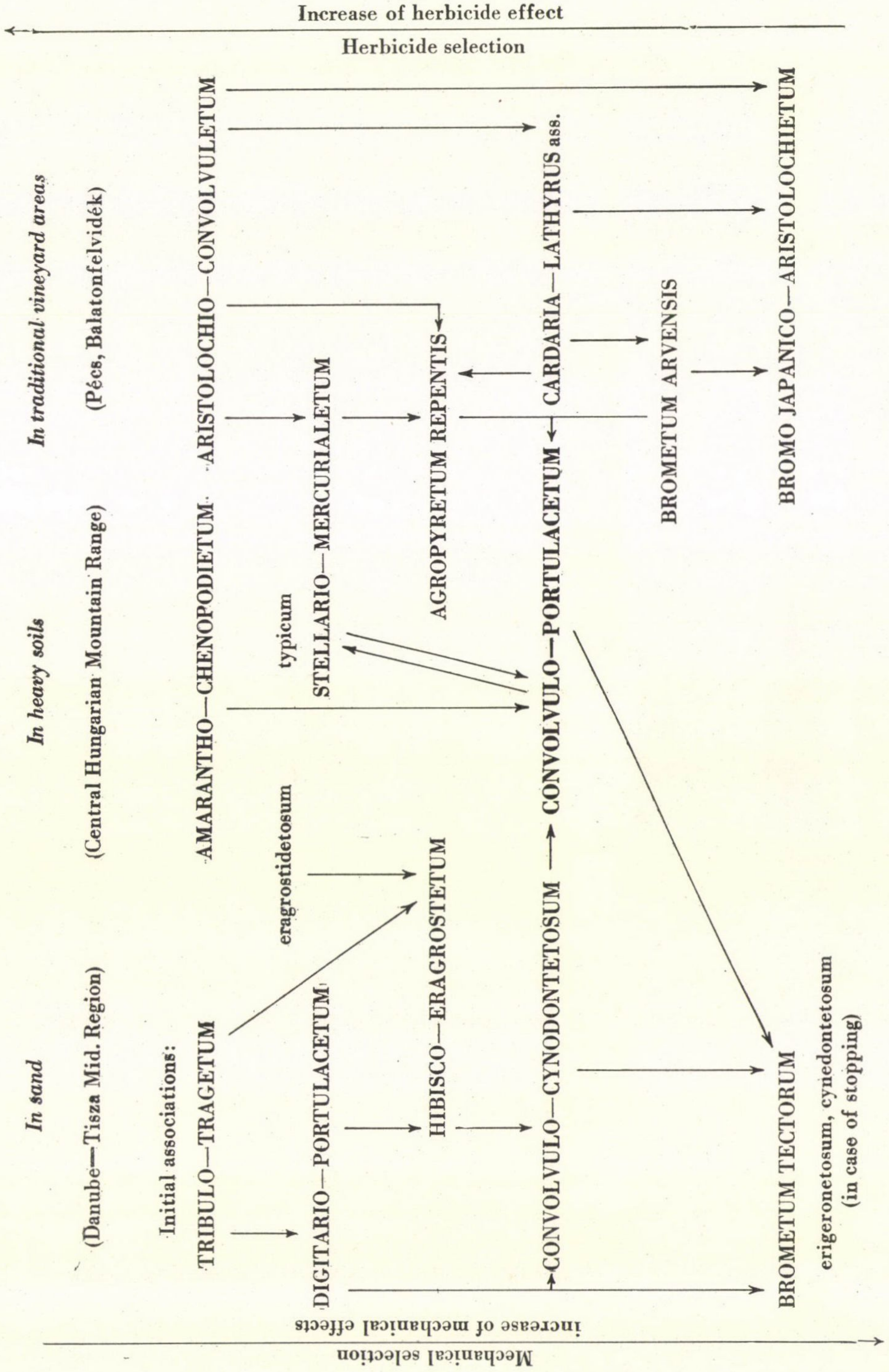


Fig. 3. The effect of herbicides and mechanical selection on the weed vegetation of vineyards

ÚJVÁROSI and the author have spent decades in examining the weed vegetation of agricultural regions in Hungary and its changes due to more intensive agrotechniques, mechanization and mainly to chemical weed killing. Figure 4 contains the results of experiments with winter wheat (cereals) and maize (row) crops carried out during the last 12 years. The national data are taken from the records of ÚJVÁROSI on wheat or maize plantings. The figure clearly shows that the leaf herbicides with a hormone base (rather among the cereals than the maize) and the aminochlor- and mercaptotriazines (in maize) have reduced the weed populations (viz. the damage due to weeds) everywhere. This reduction is more significant in maize as it has a more comprehensive effect than in the cereals. Among maize the reduction of weed cover has amounted during the last 10 or 12 years to 13—37 per cent while in winter wheat to 9—25 per cent. The results of my own experiments are of local nature (Budakalász, Keszthely) while ÚJVÁROSI's are national records based on 10 representative areas. Examining the floristic range of weed communities or rather its bio-ecological structure we can state that essential changes took place even here. Previously (TIMÁR—UBRIZSY 1957, UBRIZSY 1957, 58) it had been already stated that the advance of agrotechnology and chemical weed killing, the number and role of European, continental pontus-Mediterranean, etc. species (taken in a broader sense) are reduced in the communities. They are supplanted by annuals of cosmopolitan-adventive or Mediterranean origin. If agrotechniques increase the area of Mediterranean species, the number and role of Mediterranean or today rather cosmopolitan-adventive or Eurasian species are very significant. When discussing the life-forms it should be noted that the role of the underground over-wintering perennials (H + G + HH) is cut to approximately half especially in the summer row crops. Naturally this is most important among the perennial *Papilionaceae*. The population of the biennial (TH) species increases in most crops. The proportion of Cosm.-Adventives is very high especially among the stubble (in 3 aspects) and among the summer row crops. Together with them the most un-demanding therophytons highly adjustable to extreme conditions, have increased in number and significance (1—3 TH) while in ÚJVÁROSI's scheme (1—4 TH) the effect of intensive agrotechnology and herbicide usage is in direct proportion to the increasing role of therophyton-Cosm.-Adv., of the Mediterranean elements and is conversely related to the spread of European and continental elements (taken in a broader sense) and to the perennials.

The early spring weeds sprouting in winter (Th_2) have lost their earlier dominance under the effect of the triazines. On the other hand the number of species and cover of late summer thereophytons have increased (recorded by author as Th_3 and by ÚJVÁROSI as Th_4). At the same time, especially under the influence of herbicide selection the perennial root couch-grass (G_3) also increased, its cover grew in places. The more years an area was sprayed with

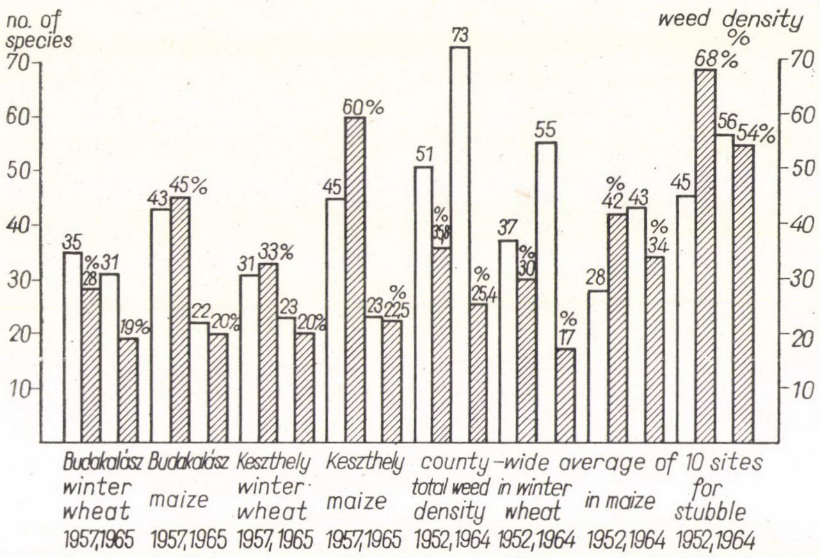


Fig. 4. Extent of the changes in weed density and number of species due to the effect of chemical treatment estimated all over the country (on an average of 10 sites) and at two sites

herbicides the greater the role they assumed. More than two-thirds of the seed populations occurring in the chemically treated cultures are composed of perennials and among them the G_3 perennials propagating under the effect of aminochlortriazine are as follows: *Convolvulus arvensis*, *Equisetum arvense*, occasional *Lepidium (Cardaria) draba*, *Lathyrus tuberosus*, *Rubus caesius v. agrestis* etc.

According to the investigations of ÚJVÁROSI covering the whole country, the number of species of segetal weeds has increased everywhere being this increase in most places considerable. In 1952 the number of species averaged 37.5, and in 1964, 55.7, while their cover was reduced from 30 per cent to 17.01 per cent. In 1952 the number of species was 28.3 and in 1964, 43.2, while the weed cover reduced from 41.77 to 33.83 per cent in the maize fields. The average number of species increased from 45.3 to 56.6, while the weed cover was reduced from 68.14 to 53.77 per cent in the stubble. Regarding the life-forms in the entire country, ÚJVÁROSI states the following: At the time of the 1952 recording the amount of perennial root couch-grass (G_3) forming the largest quantity was reduced from 13.3 per cent to 7.8 per cent although as local studies show (see above) aminochlortriazine sprays have recently made possible the aggressive increase of this form. A great reduction can be experienced among couch-grass perennials (G_1: 3.5 per cent to 1.6 per cent), among the early summer annuals sprouting in the winter (Th_2: from 5.5 per cent to 1.9 per cent) and among the early summer annuals sprouting in the spring

Table 4

Composition of the weed vegetation among winter wheat and maize at two sites due to the effect of chemical weed killing

Culture	List of species	Winter wheat	Winter wheat	Maize		Winter wheat		Maize	
		Buda-kalász 13. VI 1957	*Keszt-hely* 17. VI. 1957	*Budakalász* 21. IX. 1957	*Keszt-hely* 5. IX. 1957	*Budakalász* 2. VII. 1965	*Keszt-hely* 23. VI. 1965	*Budakalász* 18. IX. 1965	*Keszthely* 3. IX. 1965
	% of weed density	25–30	30-35	40–50	60	18–20	20	18–20	20–25
Eua. G.	*Agropyron repens*	+—1	+—1	1	+	1—2 (2)	+—1	1	+—1
Kozm. Th.	*Echinochloa crus galli*	—	—	1	1	+—1	+	1—2	2
Med.-Eua. Th.	*Setaria viridis*	+	—	1	+	+	—	+—1	—
Kozm. Th.	*Setaria glauca*	+	+—1	+—1	1	+	+—1	+	1
Kozm. Th.	*Digitaria sanguinalis*	—	+—1	—	+—1	—	+	—	+—1
Kozm. G.	*Cynodon dactylon*	—	—	—	+	—	+	+	+—1
Eua. Th.	*Apera spica venti*	—	—	—	—	+	—	—	—
Kozm. Th.	*Polygonum lapathifolium*	—	+	+	+—1	—	—	—	+
Kozm. Th.	*Polygonum aviculare*	+	+—1	+—1	+—1	—	—	—	—
Cp. Th.	*Polygonum convolvulus*	1	+—1	+	+—1	+—1	+	+	+
Kozm. Th.	*Chenopodium album*	—	—	1—2	2—3	+—1	—	+	+
Eua. Th.	*Chenopodium striatum*	—	—	+—1	+—1	—	—	+	—
Adv. Th.	*Amaranthus albus*	—	—	—	+	—	—	—	+
Kozm. Th.	*Amaranthus retroflexus*	—	—	1—2	2	+	—	+	+
Kozm. Th.	*Portulaca oleracea*	—	—	—	+	—	+	+	+
Kozm. Th.	*Stellaria media*	—	+	—	—	+(+—1)	+	—	—
Kozm. Th.	*Agrostemma githago*	+	+	—	—	—	—	—	—
Eu. Th.	*Adonis aestivalis*	+—1	+	—	—	+	—	—	—
Eu. Th.	*Consolida regalis*	1—2	1	+	+	+—1	+	—	—

Eua. Th.	*Ranunculus arvensis*	+–1	+	–	–	+	–	–	–
Eua. Th.	*Fumaria Schleicheri*	+	–	+	+–1	–	–	–	–
Eua. Th.	*Papaver rhoeas*	+–1	+	+	–	–	–	–	–
Med. Th.-TH.	*Diplotaxis muralis*	+	–	1	1–2	+	–	+	+
Eua. H. G.	*Lepidium draba*	1	+–1	+–1	+–1	1(2)	+–1	+–1(1)	+–1
Kozm. Th.	*Capsella bursapastoris*	+–1	+–1	+	+	+	+	–	–
Eu. Th.	*Raphanus raphanistrum*	1–2	–	+–1	–	+–1	–	–	–
Kozm. Th.	*Sinapis arvensis*	+–1	1	+	1	+	+	–	–
Eua. H.	*Rorippa silvestris*	+	–	+	+	+	–	–	–
Eu. Th.	*Reseda lutea*	+–1	+–1	+–1	+–1	+–1	+	+	+
Eua. Th.	*Camelina microcarpa*	+	–	+	–	–	–	–	–
Eua. H.	*Rubus caesius*	+	+	+	+	+	+–1	+–1(1)	+–1(1)
Eua. H.	*Lathyrus tuberosus*	+	+	+–1	+	+–1(1)	+	+–1	+(+–1)
Kozm. Th.	*Hibiscus trionum*	–	–	+–1	+–1	–	–	–	–
Kont. H.	*Euphorbia virgata*	–	–	+	+	+	–	–	–
Kozm. Th.	*Viola arvensis*	+–1	+	+	+	–	–	–	–
Kozm. Th.	*Anagallis arvensis*	+	+	+	+–1	–	–	–	–
Kozm. H.-G.	*Convolvulus arvensis*	1–2	+–1	1	1–2	1	+–1	+–1(2)	+–1(2)
Kont. H.	*Symphytum officinale*	–	–	–	+–1	–	–	–	+
Pont. M. Th.	*Lithospermum arvense*	+	+–1	+	–	–	–	–	–
Med. Th.	*Ajuga chamaepitys*	+	+	+–1	+	–	–	–	–
Eua. Th.	*Galeopsis angustifolia*	+	–	–	–	+–1	+	–	–
Eua. Th.	*Lamium amplexicaule*	+	+	–	–	–	–	–	–
Med. Th.	*Stachys annua*	+–1	1	1	1–2	+	+	+	+
Kozm. Th.	*Solanum nigrum*	–	–	+–1(1)	+–1	–	–	+	+
Eua. Th.	*Veronica polita*	+	–	+	–	–	–	–	–
Eua. Th.	*Antirrhinum orontium*	+	–	+	+	–	–	–	–
Eua. Th.	*Galium aparine*	–	–	–	–	+	+	–	–

Table 4 continued

Culture List of species		Winter wheat	Winter wheat	Maize		Winter wheat		Maize	
		Buda-kalász 13. VI. 1957	*Keszt-hely* 17. VI. 1957	*Budakalász* 21. IX. 1957	*Keszt-hely* 5. IX. 1957	*Budakalász* 2. VII. 1965	*Keszt-hely* 23. VI. 1965	*Budakalász* 18. IX. 1965	*Keszthely* 3. IX. 1965
% of weed density		25–30	30–35	40–50	60	18–20	20	18–20	20–25
Eua. H.	*Plantago maior*	—	+	+	+	—	—	—	—
Med. Th.	*Kickxia elatine*	—	—	+	+	—	—	—	—
Med. Th.	*Kickxia spuria*	—	—	+	+	—	—	—	—
Eua. H.	*Linaria vulgaris*	—	—	—	+	—	—	—	—
Adv. Th.	*Ambrosia elatior*	—	+	—	+	—	—	—	+
Kozm. Th.	*Centaurea cyanus*	2—3	1—2	+	+	+	+	—	—
Eua. G.	*Cirsium arvense*	3	2—3	1	+—1	+—1	+—1	+	+
Kozm. Th.	*Galinsoga parviflora*	—	—	2	1	—	—	+	—
Eua. Th.	*Matricaria chamomilla*	+	+	+	—	+—1	+—1	—	—
Kozm. Th.	*Sonchus asper*	—	—	+	+—1	—	—	—	+
Kozm. Th.	*Sonchus oleraceus*	—	—	+—1	+	+	—	+	—
Kozm. H.	*Taraxacum officinale*	+	+	—	+	+	+	+	—
No. of species		35	31	43	45	31	23	22	23

(Th_3: from 1.5 per cent to 0.5 per cent), while no essential quantitative change occurred among the late summer annuals (Th_4: from 12.7 per cent to 12.5 per cent). Finally an increase could be noted among the early spring annuals (Th_1) playing an important role. The mass appearance of this latter form is promoted also by the fact that the herbicide treatment of cereal plantings is unable to destroy the first weed aspect in which this life-form is dominant (UBRIZSY 1958). According to our examinations chemical weed killing without herbicide rotation results in the increase of 30—40 species during the last 10 years, especially in that of the hormone- and triazine resistant weeds: *Convolvulus arvensis*, *Echinochloa crus galli*, *Agropyron repens*, *Lathyrus tuberosus*, *Rubus agrestis*, *Hibiscus trionum*, *Solanum nigrum*, *Anagallis arvensis*, *Ambrosia elatior* etc. Weed grasses such as *Apera spica venti*, *Avena fatua*, *Cynodon dactylon* (in vineyards) and *Setaria* species are also spreading.

Examining the problem of selective weed killing from a phyto-sociological outlook of the community, we cannot avoid the question of the advantageous or disadvantageous role of artificial intervention. We have used selective weed killers on pioneer or more stable weed populations of fully overrun waste-grounds (e.g., *Hordeetum murini*, *Agropyretum repentis* v. *glaucae*, *Lolio–Achilleetum*, *Polygonetum avicularis*, *Poetum angustifoliae* etc.). It was striking already in the first year that the summer thereophyton plants being destroyed or suppressed relinquished their place to hibernal thereophytonous *Gramineae* or biennial and annual grasses. For instance the behaviour of *Hordeetum* deserves attention where, in addition to the *Hordeum* population, *Trifolium repens* was rather dominant at the expense of other weeds. Evidently under the influence of weed killing, a radical method, perennials especially the *Gramineae*, then certain vegetatively propagating *Papilionaceae* and other resistant perennial species are spreading among the extremely labile and speedily transforming plant populations occupying a dynamic position in natural succession which in a way implies an increase in the course of development.

In place of the *Polygonetum avicularis*, *Lolietum* which had been earlier found only sporadically began to spread while the destroyed *Amarantho—Chenopodietum* relinquished its place to large masses of *Agropyretum*. The stock of *Poetum angustifoliae* also essentially transformed under the effect of spraying with 2,4-D because the majority of dicotyledonous plants (e.g., *Plantago lanceolata*, *Cichorium intybus*, *Erigeron canadensis*, *Convolvulus arvensis*, *Leontodon autumnalis*, *Cirsium arvense*, *Melandrium album*, *Achillea millefolium* etc.) started to die or were destroyed. At the same time the grass began to regenerate quickly and formed a solid grass cover with other *Gramineae*. The most interesting phenomenon is the observation that under the influence of chemical spraying the loose lawn of *Agropyretum repentis* supplanted the annual ruderal weed populations and thus the previously useless waste-ground became relatively useful for grazing. The lawn of *Agropyretum* is useful especially on dams and embankments because it protects them from erosion. In addition to the expressedly anthropogenic influences the *Hordeetum* developing in place of *Polygonetum*, then the lawn of the succeeding *Lolietum perennis* may be regarded as most valuable plant population which in parks, sports fields, but especially alongside the roads and ditches of cities and villages provides the most economic type plants and at the same time is also an adequate fodder. Since it is conservative and permanent it usually rarely gives room to, for instance, weeds. Among the half-cultivated lawns the *Poetum angustifoliae* population must be noted as one that deserves greater attention not only for its unusual survivability, dense and compact lawn but also on account of its valuable composition. Otherwise the *Poa angustifolia* is one of the best and hardiest grass species of Hungary and for this reason it should be given preference among semiarid, semihumid conditions for future artificial turfing.

If conditions favour them among ruderal areas and under the influence of chemical weed killing the early xerophyll or mesoxerophyll therophyton communities may turn into mesophyll type meadow plant populations composed of hemicryptophytonous species. Thus in addition to the already mentioned *Poetum angustifoliae*, *Cynodontetum* and *Lolietum* populations are frequent on sandy soils while the ruderal type populations of *Festucetum pseudovinae* or the characteristic population of *Alopecuretum pratensis* are common on acidic and compact clay soils.

The practical conclusion which may be drawn is that if waste-grounds otherwise worthless for economy are sprayed at the proper time with chemicals (the time to spray is before the flowering of the most dominant species of the association) this may promote processes of development taking place there, speed up succession, which in Hungary usually results in a mesophyll lawn, and thus these areas can be relatively valuable for agriculture. Thus chemical weed killing is a valuable means for the transformation of flora by man.

REFERENCES

Balogh, J. (1953): Grundzüge der Zoocönologie. Budapest, Akadémiai Kiadó.

Ellenberg, H. (1950): Unkrautgemeinschaften als Zeiger für Klima und Boden. I. Eugen Ulmer, Stuttgart.

Ellenberg, H. (1950): Ackerunkraut-Gemeinschaften als Bodenzeiger. Stuttgart.

Ellenberg, H.—Zeller, O. (1950): Wiesengesellschaften als Zeiger für den Boden etc. Landw. Zentraldienst. Stuttgart.

Fekete, R. (1963): Változások a szántóföldi gyomnövényzetben (Changes in the Weed Flora of Plough-lands). MTA. Agrártud. Oszt. Közl., *XXII*, 377—394.

Jahn, S. (1952): Über die "Bindung" bestimmter Unkräuter und die Wintergetreidearten. Mitt. d. Floristisch-Soz. Arbeitsgemeinschaft, **3**, 113—122.

Knapp, G. (1952): Zur Frage der ökologischen Beurteilung von Acker-Standorten auf Pflanzensoziologischer Grundlage. Geobot. Mitt. I. Köln. 1—24.

Knapp, R. (1948—49): Einführung in die Pflanzensoziologie, H. **1—3**, Eugen Ulmer, Stuttgart.

Krzymowski, R. (1905): Kulturpflanzen, Unkräuter und Haustiere als Intensitätsindikatoren. Neue Mitt. f. d. Landw., **2**, 252—253.

RADEMACHER, R. (1947): Unkrautbekämpfung durch Fruchtfolgemassnahmen. Neue Mitt. f. d. Landw., **2**, 252—253.

RADEMACHER, G. (1948): Gedanken über Begriff und Wesen des "Unkrauts". Zeitsch. f. Pflanzenkrankh. u. Pflanzenschutz, **55**, 1—10.

RADEMACHER, B. (1956): Der Stand der Herbizidforschung. Pflanzenschutzkongress Berlin. 1955. 197—222.

TERPÓ, A. (1963): A herbicidhatás növénytani vonatkozásainak értékelése (Evaluation of the Botanical Aspects of the Effect of Herbicides). Kert. Szől. Főisk. Évk., *XXVII*, 275—299.

TIMÁR, L. (1957): Zönologische Untersuchungen in den Äckern Ungarns. Acta Botanica, *III*, 79—109.

TIMÁR, L.—UBRIZSY, G. (1957): Die Ackerunkräuter Ungarns mit besonderer Rücksicht auf die chemische Unkrautbekämpfung. Acta Agronomica, *VII*, 123—155.

TOMASELLI, R. (1952): Rilievi fitosociologici sull'efficacia diserbante del 2,4-D sulla flora messicola del frumento in Pavia. Rivista di Ecologia, *II*, 64—86.

UBRIZSY, G. (1950): Les associations des mauvaises herbes rudérales de la Hongrie et les aspècts agricoles du problème. Acta Agr. Acad. Sci. Hung. *I*, 107—159.

UBRIZSY, G. (1955): Recherches sur les agrophytocénoses d'un emblavure d'automne. Acta Bot. Acad. Sci. Hung. *I*, 335—359.

UBRIZSY, G. (1955): Die ruderalen Unkrautgesellschaften Ungarns. II. Studien über Ökologie und Sukzession. Acta Agr. Acad. Sci. Hung. *V*, 393—418.

UBRIZSY, G. (1958): Cönológiai kutatások agrárterületek gyomtársulásain stb. (Cenological Research on the Weed Colonies in Agricultural Areas etc.). MTA Biol. Csop. Közl., *II*, 65—78.

UBRIZSY, G. (1959): Chemische Unkrautbekämpfung auf Wiesen- und Weideflächen. Acta Agr. Acad. Sci. Hung. *IX*, 97—116.

UBRIZSY, G. (1964): Einfluss der Herbizide auf die Weiden etc. Rolnictwo, *XVII*, 159—165.

UBRIZSY, G.–CSONGRÁDY, M. (1960): Ergebnisse der mit Chlor-aminotriazin Derivaten in Ungarn durchgeführten Unkrautbekämpfungsversuche. Acta Agr. Acad. Sci. Hung. *X*, 197—227.

ÚJVÁROSI, M. (1952): Die Unkrautarten der ungarischen Ackerböden und ihre Lebensformanalyse. Acta Agr. Acad. Sci. Hung. *II*, 237—274.

ÚJVÁROSI, M. (1954): Neue Interpretation der Acker-Assoziationen. Bot. Közl., *XLV*, 183—192.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1–2), pp. 195–204 (1968)

EFFECT OF ALTERNATED FEEDING OF RESTRICTED AND ABUNDANT DIETARY PROTEIN RATIOS ON WEIGHT GAIN AND BLOOD PROTEIN FRACTIONS IN GROWING PIGS

By

L. PÉNZES, L. MENTLER

DEPARTMENT OF PHYSIOLOGY, RESEARCH INSTITUTE OF ANIMAL HUSBANDRY, BUDAPEST

Experiment with growing pigs has been carried out to evaluate the effect of alternated feeding of restricted and abundant quantities of dietary protein on weight gain, utilization of food and changes in blood protein fractions. As it was established during the 140 day experimental period, weight gain values of the experimental animals were surpassed by those of the controls. In the feeding periods of the experimental groups, in case of low protein intake, the feeding of dried sugar beet slices proved to be favourable. Rate of food utilization, expressed in starch equivalent per cent, did not show characteristic trends in the experimental groups. The values of mean digestible protein utilization per kg body weight gain were increased by thirty per cent during protein depletion period as compared with those in the control group. In the periods of protein repletion, utilization of protein decreased considerably. Weight gain in each period seemed to be significantly related to the quantitative changes of blood protein components.

Introduction

It is generally well known that protein requirements of young, growing animals have recently been investigated as follows: 1) on th ‹ basis of different feeding standards, 2) feeding by continuously limited protein ratio and 3) using the depletion—repletion technique.

Investigations dealing with the economy of continuous protein depletion have already been performed in several branches of swine fattening and breeding (ASHTON *et al.* 1955, AUNAN *et al.* 1961, BECKER *et al.* 1962, CRAMTON *et al.* 1954*a*, HANSON *et al.* 1956, MERKEL *et al.* 1958*a*). These reports suggest concordantly that limited levels of dietary protein may stimulate the rate of growth and related nitrogen utilization in the growing organism and may moderate further adiposity.

MORIN-JOMAIN *et al.* (1961, 1962, 1963) investigated the effect of periodical protein nutrition in juvenile albino rats. The authors found an accelerated growth rate, increased nitrogen retention during the periods of depletion and repletion. The results were attributed to the enhanced utilization of nitrogen of the periodically depleted and repleted animals.

Earlier results of PÉNZES (1967) suggest that the change in the levels of dietary protein may exert weight gain favourably, if the rapid changes of feeding periods causing "dietary stress" are possibly shortened. Thus, the rate of nitrogen retention is decreased in proportion with the duration of protein "starvation" period.

The dependence of protein tissue catabolism and utilization on previous quantitative protein intake is generally accepted (MURAMATSU *et al.* 1963, VAUGHAN *et al.* 1962). On the other hand, it is also recognized that the biological value of different dietary proteins can be practically evaluated by the rate of weight gain during repletion after a previous protein depletion period of the organism (HAYS *et al.* 1958, PEO *et al.* 1957, ZUCKER *et al.* 1958).

The aim of the present study is to determine the influence of variously alternated dietary protein levels on the growth of young pigs.

Materials and Methods

Eighty Hungarian Large White crossbred pigs (colony of the National Pig Fattening Enterprise's livestock, at Győr) of 24.5 $\pm$ 0.92 kg body weight were allotted into four groups (one control and three experimental groups) of twenty individuals each. Concerning the periods of dietary protein supply of the experimental groups, they were alternated in every 18, 21 and 35 days. During the repletion periods about 150 per cent, whilst in the "protein starvation phases" only 50 per cent of the actual protein requirement of the animals were given. The necessary diets were composed of usual foodstuffs and enriched during the protein repletion periods by using soya bean meal. In the course of depletion periods dried sugar beet slices were used in appropriate amounts. Efforts have been made to create dietary conditions which may be found often in practice; i.e. high level of dietary protein goes together with protein of high quality and vice versa.

Daily records were kept of food consumption, and changes in body weight in each period were also established. Blood samples were regularly collected from five animals of each group, and analysis extended to the total protein and serum albumin determination as well as alpha, beta and gamma globulin fractions, according to KORPÁCZY's procedure (KORPÁCZY 1951).

Table 1

Mean starch equivalent values and digestible protein contents of ratios, in g

Control group			Experimental groups								
			18 day group			21 day group			35 day group		
Period	Starch equiv.	Digestible protein	Period	Starch equiv.	Digestible protein	Period	Starch equiv.	Digestible protein	Period	Starch equiv.	Digestible protein
I.	840	200	I.	700	70	I.	700	70	I.	720	70
II.	1100	210	II.	1000	310	II.	1000	330			
III.	1210	210	III.	1000	110	III.	1120	110	II.	1030	330
IV.	1210	220	IV.	1200	350	IV.	1500	470			
V.	1780	280	V.	1640	160	V.	1880	320	III.	1700	160
VI.	2070	330	VI.	1900	420	VI.	1970	190			
VII.	2420	340	VII.	2160	140	VII.	2300	480	IV.	2300	510
VIII.	2420	370	VIII.	2400	550						

Notice: Ratios fed during depletion contained appr. 18 per cent dried sugar beet slices

Results and Discussion

Results are demonstrated in the figures and tables. Figure 1 represents the weight gain of pigs during the 140 day experiment. Characteristics of the curves demonstrate that the mostly marked weight gain occurs in case of the control animals. It can be established that the influence of depletion and

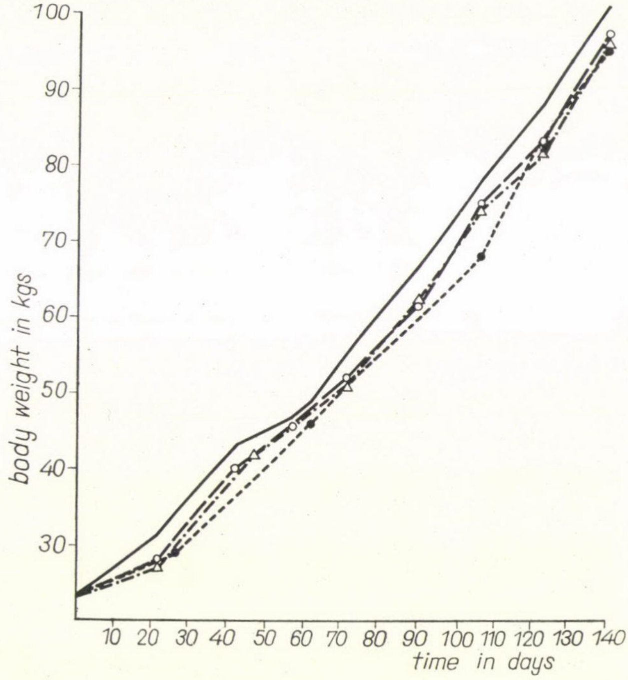


Fig. 1. Effect of alternated feeding of restricted and abundant dietary protein ratios on weight gain of growing pigs. (———— control group. – – – – – – – "18 day group". .-.-.-.-.-.-. "21 day group". - - - - - - - - - - "35 day group")

repletion periods was less pronounced on the individual weight gain, as an eventual effect of the periods concerned could be observed.

The author's other studies (PÉNZES 1967) might call attention to the fact that an instant response of body weight changes can be obtained when rats are protein depleted and repleted alternatively. The "slopes" of the weight gain curves of such rats are concordant to the dietary changes. Nevertheless, PEO *et al.* 1957*a* and PEO *et al.* 1957*b* have emphasized that even protein-free diet given for seven days to two weeks old piglets, did not produce significant losses of body weight.

Similar results were reported by ZUCKER *et al.* (1958), however, their observations were not interpreted in details either. As a result of our data obtained from rat experiments, the higher sensitivity of animals to the changes of protein supply can be regarded as a different physiological response of the experimental individuals. Such responses may be independent of age, as suggested by ZUCKER *et al.* (1958).

Details of the individual weight gain data in each experimental group are shown in Tables 2, 3 and 4. These data are demonstrated as diagrams in Figs 2, 3 and 4. It seems clear that in the last thirds of the trial, the average daily weight gain of the experimental animals proved to be greater than that of the controls. The rate of food utilization increased up to the fiftieth day of experiment, however, lower values appeared gradually as the trial periods advanced. This was observed either in the control or in the experimental groups. As the experiment advanced, difference in the utilization of food between

Table 2

Weight gain and rate of food utilization of experimental animals in the 18 day depletion—repletion cycle

Period	Weight gain in kg	Mean daily weight gain in g	Starch equivalent, g (per 1 kg gain)	Digestible protein, g (per 1 kg gain)	Percentile utilization of starch equivalent
I.	90	225	3284	321	30.4
II.	240	600	1638	516	61.1
III.	110	366	2615	285	38.2
IV.	135	450	2569	763	38.9
V.	190	500	3099	298	32.3
VI.	265	828	2293	509	43.6
VII.	170	500	4121	435	24.3
VIII.	275	764	3813	716	26.2
Total	1475	527	2894	509	34.6
Control group					
I.	168	420	2146	446	46.6
II.	235	588	1957	408	51.1
III.	75	250	4829	853	20.7
IV.	140	491	2491	424	40.1
V.	230	637	2643	413	37.8
VI.	210	691	2997	472	33.4
VII.	190	588	3854	582	25.9
VIII.	255	746	3239	498	30.9
Total	1503	553	2879	483	34.7

Table 3

Weight gain and rate of food utilization of experimental animals in the 21 day depletion—repletion cycle

Period	Weight gain in kg	Mean daily weight gain in g	Starch equivalent, g	Digestible protein, g	Percentile utilization of starch equivalent
			per 1 kg gain		
I.	75	188	3935	384	25.4
II.	290	580	1781	566	56.1
III.	190	380	2936	292	34.1
IV.	220	579	2606	808	38.2
V.	245	766	2450	411	40.8
VI.	140	412	4934	475	20.3
VII.	305	847	2678	563	37.3
Total	1465	523	2765	522	36.2
Control group					
I.	168	420	2146	446	46.6
II.	260	520	2233	451	44.8
III.	190	392	3107	537	32.2
IV.	230	637	2643	413	37.8
V.	210	691	2997	472	33.4
VI.	190	588	3854	582	25.9
VII.	255	746	3239	498	30.9
Total	1503	553	2879	483	34.7

experimental and control individuals became less significant. Results are presented in Table 5. It appears that the utilization of starch value was most favourable in the "21-" and "35 day group" in case of the consumed quantity of starch required for 1 kg body weight gain. The animals of these groups have consumed of dried sugar beet slices by 15 and 12 per cent less than that of the pigs of the "18 day group". Although the main weight gain of the experimental animals was exceeded by that of control individuals, these data, however, suggest that the utilization of food in pigs, fed alternately by restricted and abundant quantities of protein, was in average higher than might be expected from the lower weight gain values. Our data may attract attention to the use of dried sugar beet slices which has up till now unreasonably disregarded as food in pig fattening. It is evidently appropriate to supply the dry-matter and energy requirement of pigs fed on low protein level.

Table 4

Weight gain and rate of food utilization of experimental animals in the 35 day depletion—repletion cycle

Period	Weight gain in kg	Mean daily weight gain in g	Starch equivalent, g	Digestible protein, g	Percentile utilization of starch equivalent
			per 1 kg gain		
I.	110	220	3411	328	29.3
II.	340	486	2113	676	47.3
III.	450	500	3328	305	30.0
IV.	560	800	2827	640	35.4
Total	1460	521	2859	522	35.0
Control group					
I.	227	454	2097	436	47.7
II.	281	404	2912	552	34.3
III.	550	643	2681	426	37.3
IV.	445	669	3502	534	28.6
Total	1503	553	2879	483	34.7

Table 5

Effect of alternated feeding of restricted and abundant dietary protein ratios on weight gain and food utilization
(Summary of results)

Animals	Mean daily weight gain in g	Consumed starch equivalent per one kg body weight gain in g	Consumed digestible protein per one kg body weight gain in g	Percentile utilization of food expressed in starch equivalent	Food consumed per one kg body weight gain in kg	Dried sugar beet slices consumed per one kg body weight gain in kg
"18 day group"	527	2894	509	34.6	3.65	0.34
"21 day group"	523	2765	522	36.2	3.53	0.29
"35 day group"	521	2859	522	35.0	3.65	0.30
Control group	553	2879	483	34.7	3.88	—

Figures 5 and 6 show the data of the blood protein analyses. Apparent concordance can be found in changes of protein fractions if the alternations of total serum protein and serum albumin are considered as the results of the periods of depletion and repletion of dietary protein supply. Nevertheless, percentile changes in the total protein of serum can by no means be regarded as an absolute diminution or increase in quantities of blood protein, rather an

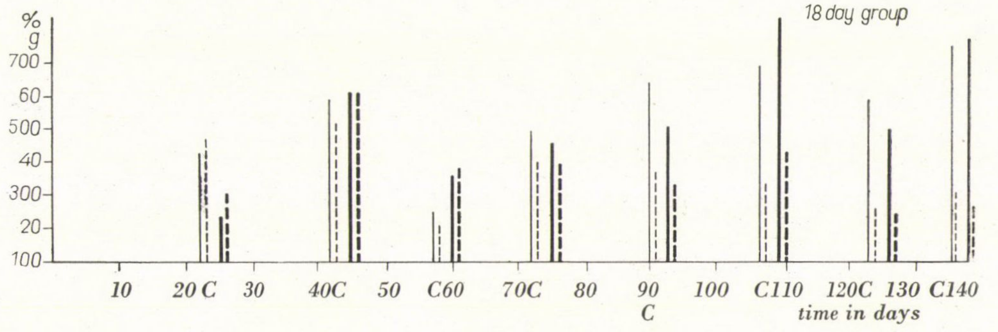


Fig. 2. **Daily weight gain and food utilization in different feeding periods (Vertical lines represent the daily weight gain in grams and the percentile food utilization. Marks "C" on the horizontal line represent the appropriate values of the control animals. Continuous verticals represent daily body weight gain whilst dotted verticals demonstrate food utilization)**

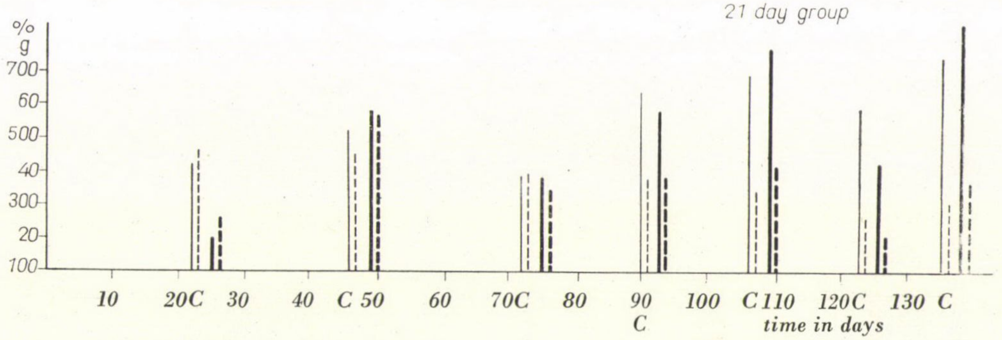


Fig. 3. **Daily weight gain and food utilization in different feeding periods (Vertical lines represent the daily weight gain in grams and the percentile food utilization. Marks "C" on the horizontal line represent the appropriate values of the control animals. Continuous verticals represent daily body weight gain whilst dotted verticals demonstrate food utilization)**

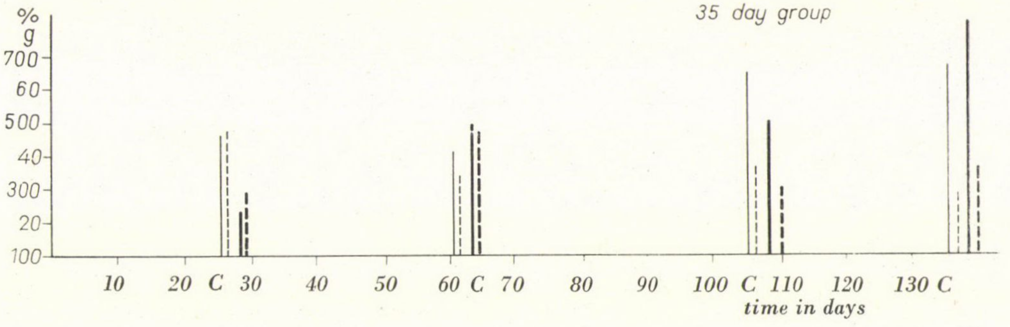


Fig. 4. **Daily weight gain and food utilization in different feeding periods (Vertical lines represent the daily weight gain in grams and the percentile food utilization. Marks "C" on the horizontal line represent the appropriate values of the control animals. Continuous verticals represent daily body weight gain whilst dotted verticals demonstrate food utilization)**

eventual change in plasma volume as a frequent concomitant phenomenon following rapid alternations in the dietary protein supply. Accordingly, ALLISON *et al.* (1946) and HEGSTED *et al.* (1953) observed plasma volume to decrease during depletion while the extravascular fluid volume was accumulated.

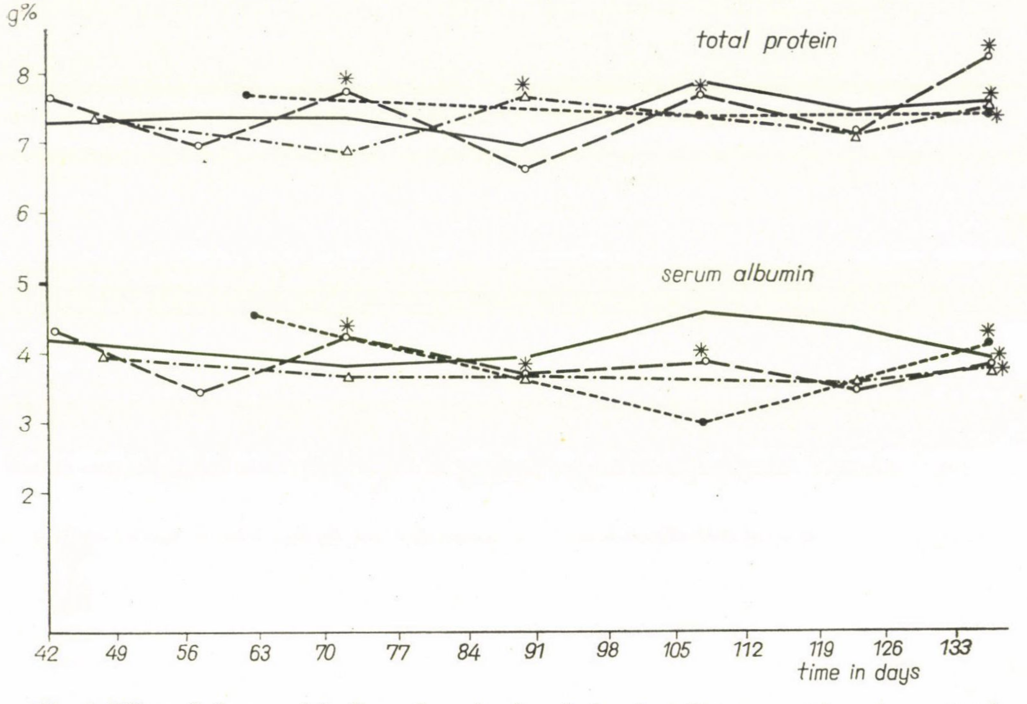


Fig. 5. Effect of alternated feeding of restricted and abundant dietary protein ratios on total serum protein level and serum albumin per cent. (Points marked by * represent the terms of repletion periods; signs of curves as indicated in Fig 1)

No significant differences could be stated in the quantitative values of alpha, beta and gamma globulins. The fall of serum albumin level during protein depletion refers partly to a diminished synthesis of albumin in the liver tissue, partly to an increased catabolism of this type of protein. In connection with the insignificant change of the total serum globulin value, we should refer to the statements of ZELDIS *et al.* (1945). They have emphasized that the fall in albumin level produced by dietary protein restriction is more intensive than the globulin loss itself. Contraversely, WEIMER *et al.* (1963) report that in rats kept only on 50 per cent of their maintenance requirement, significant fall of total serum protein, albumin, alpha-1 and beta globulin fractions could be stated after a loss of 12, 26 and 33 per cent of their body weight, respectively. As concerns the levels of alpha-2 and gamma globulin, the observed changes were unimportant. In the periods of repletion, when animals regained their initial body weights, total protein, albumin, alpha-1 globuline level remained unchanged, or decreased whilst alpha-2 and gamma globulin fractions increased considerably. The authors have attached their

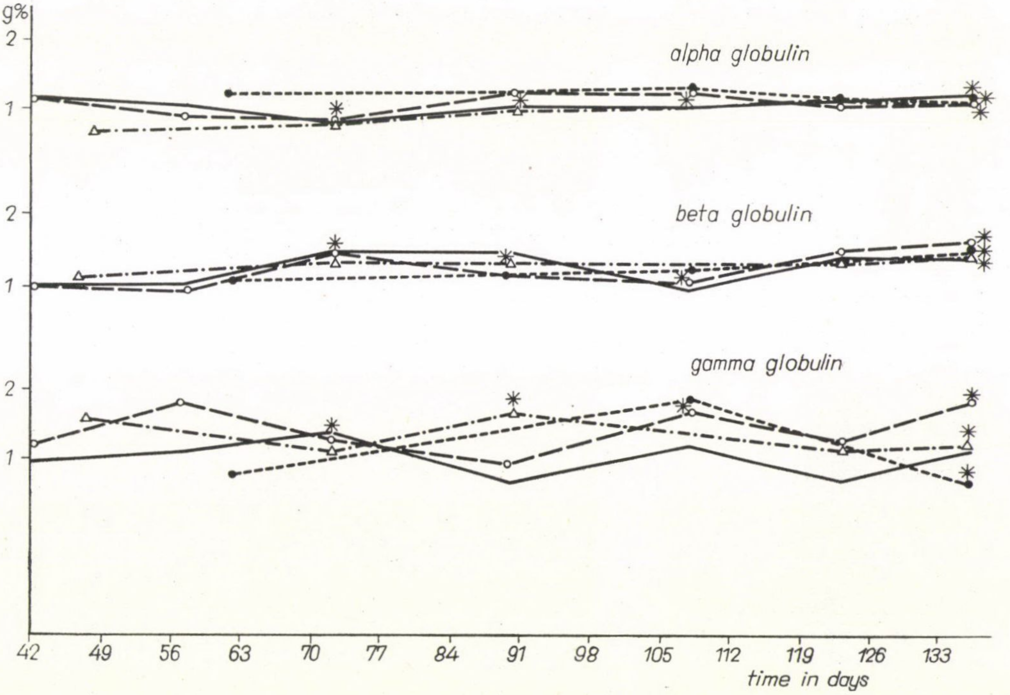


Fig. 6. Effect of alternated feeding of restricted and abundant dietary protein ratios on total serum protein level and serum albumin per cent (Points marked by * represent the terms of repletion periods; signs of curves as indicated in Fig. 1)

explanations to these findings by saying that the changes are due partly to some maintaining mechanisms of biological defense and partly to the supposed functional shift among the proportions of certain labile proteins.

REFERENCES

ALLISON, J. B.—SEELEY, R. D.—BROWN, J. H.—FERGUSON, F. P.(1946): Some Effects of Depletion and Repletion in Proteins on Body Fluids in Adult Dogs. Proc. Soc. Biol. Med., **63,** 214—217.

ASHTON, G. C.—KASTELIC, J.—ACKER, D. C.—MADDOCK, H. M.—KLINE, E. A.—CATRON, D. V. (1955): Different Protein Levels with and without Antibiotics for Growing-finishing Swine: Effect on Carcass Leanness. J. Anim. Sci., **14,** 82—89.

AUNAN, W. J.—HANSON, L. E.—MEADE, R. J. (1961): Influence of Level of Dietary Protein on Live-weight Gains and Carcass Characteristics of Swine. J. Anim. Sci., **20,** 148—156.

Becker, D. E.—Jensen, A. H.—Breidenstein, B. C. (1962): Limited Feeding for Finishing Swine. Mimeo. AS-571, Dept. Anim. Sci. Univ. Ill.

Cramton, E. W.—Ashton, G. C.—Loyd, L. E. (1954*a*): The Effect of Restricted Food Intake of Market Hogs during the Finishing Period on the Quality of the Bacon Carcass. J. Anim. Sci., **13**, 321—325.

Hanson, L. E.—Ferrin, E. F.—Aunan, W. J. (1956): The Effect of Limited Feeding on Growth and Reproduction of Gilts. Mimeo. H-138, Dept. Anim. Husb., Inst. Agric. Univ. Minn. 6. Minn.

Hays, V. W.—Speer, V. C.—Catron, D. V. (1958): Application of the Protein Depletion—repletion Technique in Baby Pig Feeding Experiments. III. Comparison of the Depletion—repletion Technique with Conventional Growth Feeding Trials. J. Nutr., **65**, 63—75.

Hegsted, D. M.—Milner, J. P.—Wilson, D.—Ginns, P. (1953): Changes in Muscle Water and Composition Induced by Protein Depletion in Rats at Two Environmental Temperatures. Amer. J. Physiol., **172**, 14—22.

Korpáczy, L. (1951): Szérumfehérje frakciók meghatározása (Determination of Serum Protein Fractions). Kisérl. Orvostud., **1**, 1—3.

Merkel, R. A.—Bray, R. W.—Grummer, R. H.—Phillips, P. H.—Bohstedt, G. (1958*a*): The Influence of Limited Feeding Using High Fiber Rations, upon Growth and Carcass Characteristics of Swine. I. Effect upon Feed-lot Performance. J. Anim. Sci., **7**, 3—9.

Morin-Jomain, M. (1962): Le Comportement Nutritionnel du Rat Soumis à des Restrictions Alimentaires Périodiques Suivies de Réalimentation. Archiv. Sciences Physiologiques, **16**, 441—456.

Morin-Jomain, M. (1963): Le Comportement Nutritionnel du Rat Soumis Alternativement a des Régimes Protéiqrives et à des Régimes Protéiques. Archiv. Sciences Physiologiques, **17**, 55—74.

Morin-Jomain, M. J.—Trémolieres, J.—Abraham, O.—Champigny, O.—Jacquot, R. (1961): Influence de restrictions alimentaires périodiques sur le comportement nutritionnel du rat blanc: poids vif, bilan azoté, dépense énergetique. Comptes rendus des séances de l'Académie des Sciences, t. **252**, 3142—3144.

Muramatsu, K.—Sato, T.—Ashida, K. (1963): Dietary Protein Level and the Turnover Rate of Tissue Proteins in Rats. J. Nutr., **81**, 427-433.

Pénzes, L. (1967): Effect of Consecutive Protein Depletion and Repletion on the Growth of Albino Rats. Acta Biol. Acad. Sci. Hung., **18**, 335—344.

Peo, E. R. jr.—Hays, V. W.—Ashton, G. C.—Speer, V. C.—Liu, C. H.—Catron, D. V. (1957*a*): Application of the Protein Depletion–repletion Technique in Baby Pig Feeding Experiments. I. A Comparison of Levels and Sources of Protein for Baby Pigs. J. Nutr., **62**, 465—474.

Peo, E. R. jr.—Hays, V. W.—Ashton, G. C.—Speer, V. C.—Liu, C. H.—Catron, D. V. (1957*b*): Application of the Protein Depletion–repletion Technique in Baby Pig Feeding Experiments. II. Effect of Levels of Protein on Repletion Gains and Blood Serum Components of Baby Pigs. J. Nutr., **62**, 475—488.

Vaughan, O. W.—Filer, L. J. jr.—Churella, H. (1962): Influence of Prior Dietary Protein Levels on Resistance to the Stress of Protein Depletion. Pediatrics, **29**, 90—97.

Weimer, E. H.—Godfrey, J. F.—Meyers, R. L.—Miller, J. N. (1963): Effects of Food Restriction and Realimentation on Serum Proteins: Complement Levels and Electrophoretic Patterns. J. Nutr., **81**, 405—410.

Zeldis, L. J.—Alling, E. L.—McCoord, A. B.—Kulka, J. P. (1945): Plasma Protein Metabolism-electrophoretic Studies. Chronic Depletion of Circulating Proteins during Low Protein Feeding. J. Exp. Med., **82**, 157—179.

Zucker, H.—Hays, V. W.—Speer, V. C.—Catron, D. V. (1958): Evaluation of Pumpkin Seed Meal as a Source of Protein for Swine Using a Depletion—repletion Technique. J. Nutr., **56**, 327—334.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 205—214 (1968)

SHORT-STRAWED MUTANTS OF KARCAG 522 WINTER WHEAT INDUCED BY GAMMA RAYS

By

P. VIGLÁSI

COLLEGE OF AGRICULTURE, DEBRECEN

We have treated the dry seeds of *Karcag 522* winter wheat with gamma-emitting ^{60}Co in the autumn of 1960. The radiation dosage employed was 20 000 R, 25 000 R and 30 000 R. Our purpose was to produce a mutant with a shorter and stiffer straw than the original 120—125 cm tall plants. In the X_3 generation we succeeded in getting 50—60 cm tall plants which produced in 1965 an X_5 generation with stable, 70 cm tall mutant strains. The rust resistance of the mutant strains also improved over that of the original plant.

Introduction

Nowadays the production of mutant stock — alongside of the classical method — is beginning to play an increasingly important role in modern plant improving. By producing the new variety in such a way we can save approximately half the time — according to GAUL (1961) — necessary for breeding a new mutant.

The effects of ionizing radiation have been examined since 1900. But practical results were gained at the beginning of the 1930s when the first compact-headed, stiff-strawed barley mutants were produced in Sweden.

For quite some time the radiation of wheat varieties has been known in literature. STADLER (cit. BOROJEVIC, 1963) treated *T. monococcum* and *T. aegilopoides* with X-rays as early as 1929 and succeeded in distinguishing chlorophyll mutants. These experiments were followed by the works of DELAUNAY (1934), SZAPEGIN (1935) and GUSTAFSSON (1941).

Many researchers report on winter wheat mutants with shorter and firmer straw as the result of irradiation. Thus for instance PRIADCENCU *et al.* (1960) found that higher dosages of irradiation produced individuals with shorter straws. ZSCHEGE—HAARRING (1962) achieved varieties with changed straw lengths by using various chemicals (short, long, short and thick stems). BOZZINI—AVANZI (1962) produced stiff-strawed mutants from a durum variety *(Capelli)* with X-rays. SCOSSIROLI (1963) experienced a reduction in number and length of the internodes resulting in shorter individuals. TAVCAR (1962), BOROJEVIC (1963), SCARASCIA—BOZZINI (cit. BÁLINT 1965) produced shorter strawed individuals by the use of irradiation. SCALFATI—ALLESANDRONI (1965) brought about a 2—3 cm reduction in stem by irradiating the F_1 generation of winter wheat hybrids.

Subjecting the seeds to a radiation dosage of 20 000—25 000 R generally resulted in short-strawed mutants, but a higher dosage was usually 100 per cent lethal.

According to MAC KEY (1961) and SCOSSIROLI (1963) selection must start for improving purposes at the M_3 or R_3 generations, respectively, because better results are gained than at the M_2 or R_2 levels. The rate of dosage necessary for inducing mutations is of a wide range for winter wheat. The most generally used dosages are between 5000 and 30 000 R units. According to NYBOM (1958) 15 000–20 000 R units are most useful for treating the dormant seeds of winter wheat.

Material and Methods

We have used the *Karcag 522* winter wheat *(Triticum aestivum* var. *erythrospermum* Körn.) for our mutation experiments.

The *Karcag 522* winter wheat is 120—125 cm tall, productive with medium-stiff straw, very good winter hardiness, and tillering capacity. The weight of 1000 grains is 36—37 g and it has a medium resistance to fungi.

The dry seeeds were subject to gamma rays (^{60}Co) two months after harvesting, in the beginning of September, 1960. The irradiation was done by the Isotope Laboratory of the Csepel Iron and Metal Works. The dosage was as follows: 20 000 R, 25 000 R and 30 000 R.

The irradiated and untreated seeds were sown on the test plots of the Agricultural Experimental Institute of Nagykunság (Karcag) on Oct. 24, 1960. Row and plant distances were 30 cm and 10 cm, respectively, in every treatment using 27 360 seeds. The examination of the plants of the X_2 and X_3 generations was carried out at the Institute, while the X_4 and X_5 generations in the exhibition gardens of the College of Agriculture in Debrecen. During the experiments we used the pedigree method.

Results

The germinating ability of the irradiated seeds was examined in the laboratory before sowing. Irradiation did not essentially influence germinating ability even in case of the largest dosage rates. While the germinating ability of the untreated seeds was 97 per cent, that of the irradiated ones was 93 per cent in case of 20 000 R units, 89 per cent at 25 000 R and 85 per cent at 30 000 R. Even when using the largest dosage we experienced only a 12 per cent reduction.

When sown in field conditions the seeds normally sprouted. Later, as they grew, embryo and root lethality occurred which resulted in extensive destruction. The destruction was greatest among the seeds receiving 25 000 and 35 000 R dosages and 90 per cent of the plants died.

The growth of plants surviving the radiation was increased in case of smaller dosages of radiation (20 000 R), while in case of larger dosages it was stunted. Under the effect of radiation, most of the plants surviving had defective and deformed development. The least defective were those receiving the 20 000 R units and the most at 25 000 R. According to our examination on May 17th we found that the growth of certain plants treated with 25 000 R was very stunted in comparison to the rest of the plants of the plot. The leaves protecting the head did not open but were shrivelled at the top and broke off in a circle at the tip of the head. These deformed heads were lemon-yellow. After shooting the stems of many plants broke off and the head primordia became destroyed. This phenomenon occurred in the following percentages: 1.22 per cent at 20 000 R, 15.08 per cent at 25 000 R, 2.91 per cent at 30 000 R (Table 1).

Table 1

Effect of irradiation in the X_1 of the Karcag 522 winter wheat

Dosage	No. of grains planted	Harvesting %	Plants remaining in the control %	Headless plants	
				No.	%
Control	27 360	48.30	100.00	—	—
20 000 R	27 360	17.24	35.69	58	1.22
25 000 R	27 360	6.91	14.31	285	15.08
30 000 R	27 360	6.49	13.43	69	2.91

We replanted the seeds of the plants harvested on July 3, 1961, in 25×12 cm spacing. Since our purpose was to gain short-strawed mutants, we examined and marked these plants during the growing period. The stock began to segregate in the X_2 generation and we could select individuals 20—30 cm shorter than the original plants. The control *Karcag 522* was 120 cm high while the selected individuals were 90—100 cm tall. The number of grains per plant varied between 2 and 944. The amount of short-strawed individuals developed under the effect of the various dosages may be seen in Table 2.

Table 2

Effect of irradiation on the straw height of Karcag 522 winter wheat

Dosage	No. of grains planted	No. of plants at harvesting	No. of plants with straw 90—100 cm tall	No. of grains per plant	
				least	most
20 000 R	1800	1425	114	8	661
25 000 R	1800	1392	131	2	944
30 000 R	1800	1471	56	31	809

The selection of 90—100 cm tall plants gained in the X_2 generation was continued in 1962—1963. In the 20 000—30 000 R treatments we did not gain short-strawed mutants; among those treated with 25 000 R units there were three 50—60 cm tall plants. These three individuals were entirely different phenologically than the original form. The leaves were broader, more foliate,

Fig. 1. Short-strawed mutants which became segregated in the X_3 generation

their colour was deeper green and they were bloomy. The plant was very tillered, procumbent-type. They were characterized by shorter and thicker straws. The type is introduced in Fig. 1. The three short-strawed mutants were gained from 30 000 seeds. Thus, in this case the rate of mutation was only 0.01 per cent.

On October 11, 1963, 336 seeds of the three short-strawed mutants were planted. Of these 303 sprouted. The number of plants (X_4) counted in the spring was 280. They matured 4 days sooner than in case of the controls.

In the X_4 generation we found a certain degree of back mutation because 35 plants (12.5 per cent) of the 280 became identical with the original plants. The other 245 plants were phenologically identical with those of the X_3 generation.

Out of the 245 plants the shortest strawed individuals (9) were after harvesting separated, then analyzed. The obtained results, compared to the control, are presented in Table 3. As it may be seen from the table the short-strawed mutants were better than the controls regarding the number of tillers

Table 3

Data on the short-strawed winter wheat mutants produced in the X_4 generation with a dosage of 25 000 R

Debrecen, 1963/64

Mutant	No. of buds	No. of heads	Length of head, cm	No. of flowers produced	Length of straw, cm	No. of grains		Weight of grains		Weight per
						Total	per head No.	Total	per head, g	1000 grains, g
No. 1	8	7	10	3	60	205	29.3	3.8	0.54	18.54
No. 2	13	7	8	3	46	90	12.9	2.5	0.36	27.78
No. 3	12	5	11	3	53	106	21.2	2.7	0.54	25.47
No. 4	14	8	9	3	45	260	32.5	6.9	0.86	26.54
No. 5	9	7	11	3	65	142	20.3	3.6	0.51	25.35
No. 6	18	14	12	3	60	351	25.1	8.2	0.59	23.33
No. 7	15	9	12	3	52	125	13.9	3.4	0.38	27.20
No. 8	10	7	11	3	50	228	32.6	4.9	0.70	21.50
No. 9	15	10	10	3	50	130	13.0	2.7	0.27	20.77
Nos 1—9 average:	12.7	8.2	10.4	3	53	182	22.3	4.3	0.53	24.05
Control average:	11.4	9.3	10.0	3	115	277	29.9	7.8	0.90	27.56
± Deviation from the control										
a) In absolute figures:	+ 1.3	— 1.1	+0.4	±0	—62	—95	— 7.6	— 3.5	— 0.37	— 3.51
b) In %	+11.4	—11.8	+4.0	±0	—53.9	—34.3	—25.4	—44.7	—41.7	—12.7

Fig. 2. The mutant strains Nos 3, 4 and 5 in the X_5 generation (on April 24th)

Fig. 3. After heading the mutant strain No. 4

(11.4 per cent) and the length of the head (4.0 per cent). The rest of the examined factors showed, on the whole, a change towards the worse in the mutants. If, however, we examine the individual mutants, we find that they reached the controls and in many instances they surpassed them.

Fig. 4. The 70 cm strawed mutant and the original *Karcag 522* winter wheat

The 25 000 R dosage drastically reduced the length of the stem which became 53 cm (i.e., 62 cm shorter than the control varieties). This corresponds to a 53.9 per cent reduction.

The produce of the 9 analyzed plants gained in the X_4 generation was planted on Oct. 15, 1964, with the produce of each plant sown in a separate plot. Sprouting was quite weak in case of the No. 2, 3 and 5 mutant strains. This is clear even in Plate 2 which was photographed on April 24th. The mutants produced by gamma rays are half as tall as the other preceding wheat varieties and there is a great backwardness in their development too. The detailed results may be found in Table 4.

From the data of the given table it may be seen that mutant strains Nos 3, 6, 7, 8 and 9 exhibited back mutation even at the X_5. But already in this particular year the mutant strains Nos 1, 2, 4 and 5 showed complete

Table 4

Data in the X_5 generation of the short-strawed winter wheat mutants segregated in the X_3
Debrecen, 1964/65

Mutant	Winter	spring	harvesting	Over-wintering %	Harvest %	Heading time	Ripening	Rust 5—1 stem	Rust 5—1 leaf	low	high	Segregation, %		Straw height, cm		Weight/1000 grains	
	No. of plants/plot							P. gr.	P. tr.	plants segregated No/plot		low	high	low	high	low	high
No. 1	147	142	86	97	59	VI. 10	VII. 18	4	4	86	—	100	—	70	—	26.54	—
No. 2	11	11	9	100	82	VI. 15	VII. 19	4	4	9	—	100	—	65	—	24.74	—
No. 3	13	13	11	100	84	VI. 17	VII. 20	3	4	9	2	82	18	80	110	20.86	27.31
No. 4	75	75	59	100	79	VI. 10	VII. 19	4	4	59	—	100	—	70	—	28.40	—
No. 5	16	15	14	99	87	VI. 13	VII. 19	4	4	14	—	100	—	75	—	27.66	—
No. 6	106	104	52	98	49	VI. 6	VII. 18	3	4	34	18	65	35	80	125	29.26	33.10
No. 7	56	55	30	99	54	VI. 6	VII. 19	2	2	18	12	60	40	65	123	28.34	34.80
No. 8	78	76	29	98	37	VI. 3	VII. 19	1	3	14	15	48	52	80	120	29.06	37.30
No. 9	62	61	36	99	58	VI. 6	VII. 19	1	1	32	4	89	11	80	120	26.94	32.77
Control	54	52	51	96	94	V. 31	VII. 17	3	3	—	—	—	—		125		33.80

stability. The strain No. 4 showed an especially stable form and even its other features are better than those of the original stock. Their overwintering and drought resistance abilities are very good. They prove to have a very great resistance to *Puccinia graminis* and *Puccinia tritici* while being slightly susceptible to *Erysphe graminis*. The straw is strong, thick, 70 cm tall. They mature 2—3 days later than the controls. Mutant strain No. 4 after heading may be seen on Fig. 3.

In comparison to the original stock the short-strawed mutant strains have a weak point: their lower weight per 1000 grains — as an inherited property — is very important for productivity. The test plants were 7 grams lighter than the control variety in this year.

A comparison of the original and short-strawed mutant individuals may be found in Fig. 4. The original *Karcag 522* winter wheat is 125 cm tall and the mutant (X_5) is 70 cm tall (i.e., 56 per cent shorter than the original plants).

The best mutant strains which proved to be stable in 1965 were planted in small plots in a comparative experiment to judge the productivity of the strains. Part of the material will be used as improving stock (one of the crossing partners) in order to produce new varieties.

REFERENCES

BÁLINT, A. (1960): Sugárbiológiai módszerek alkalmazása a növénynemesítésben (The Application of Radiation Biological Methods to Plant Improving). Növénytermelés, **9**, 181—190.

BÁLINT, A. (1965): "Mutánsok felhasználása a növénynemesítésben" c. konferenciáról, (On the "Use of Mutants in Plant Improvement" Conference). MTA Biol. Tud. Oszt. Közl., *VIII*, 119—124.

BOROJEVIC, K. (1963): Delovanje X-zraka i termalnih neutrona na neke sorte *Triticum* speciesa. Savremena Poljeprivreda, Novi Sad, **11**, 181—201.

BOZZINI, A.—AVANZI, S. (1962): Solid Stem: a Radiation Induced Mutation in *Triticum durum* Desf. Caryologia, Firenze. **15**, 525—535.

DELAUNAY, L. (1934): Experimental erzeugte Mutationen bei Weizen. Res. Gen., **10**, 56.

GAUL, H. (1961): Use of Induced Mutants in Seed-propagated Species. Nat. Acad. Sci.-Nat. Res. Con., Washington, Publication, 206—240.

GUSTAFSSON, A. (1941): Mutation Experiments in Barley. Hereditas, **27**, 225—242.

MAC KEY, J. (1961): Methods of Utilizing Induced Mutations in Crop Improvement. Mutation and Plant Breeding, Washington, **891**, 336—364.

NYBOM, H. (Нибом, X.) (1958): Селекция растений с помощью индуцированных мутаций. Агробиология, **5**, 15—29.

PRIADCENCU, A. L. *et al.* (1960): Az X-sugarakkal és termikus neutronokkal besugárzott magvakból származó A-15 őszi búza viselkedése (The Behaviour of the A-15 Winter Wheat Originating from Seeds Irradiated with X-rays and Thermal Neutrons). Probl. Act. de Biol. Sti. Agr., Bucuresti, **780**, 581—590.

SCALFATI, M. C.—ALESSANDRONI, A. (1965): Applicazione di radiazioni ionizzanti per la introduzione di caratteri utili in ibridi interspecifici e intergenerici de Triticum durum. Gen. Agr., Pavia **19**, 224—242.

SCOSSIROLI, R. E. (1963): A mennyiségi jellegek öröklése és populációk genetikai változékonysága növelésének eszközei (Means of Increasing the Inheritance of Quantitative Characteristics and Genetical Variability of Populations). MTA Biol. Tud. Oszt. Közl. **3—4**, 297—318.

SZAPEGIN, A. A. (1935): X-ray Mutants in Soft Wheat. Bull. Appl. Bot. Gen. Pl. Breed. Ser., 2, 9.
TAVCAR, A. (1962): Korsne mutacije prizvedne radijacijom gamma-zracima kod nekin specijesa psenice. Arh. Poljopr. Nauke, Beograd, 15, 20—30.
ZSCHEGE, CHR.—HAARRING, R. (1962): Mutationsauslösung durch Chemikalien bei Weizen, II. Zeitsch. für Pflanz., Berlin—Hamburg. 48, 55—68.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 215—222 (1968)

TEST ON TERPENOIDS PRESENT IN PARTS OF CORIANDRUM SATIVUM L.

II. THIN-LAYER CHROMATOGRAPHIC AND HISTOCHEMICAL EXAMINATIONS OF THE LINALOOL AND THE ALDEHYDES

By

ZS. LASSÁNYI, K. LŐRINCZ

NATIONAL INSTITUTE FOR AGRICULTURAL QUALITY TESTING AND SCIENTIFIC RESEARCH
INSTITUTE FOR MEDICINAL PLANTS, BUDAPEST

Histochemical and thin-layer chromatographic examinations have been performed in the course of ontogenesis, with *Coriandrum sativum* L. var. "Lucs". It has been established that in the vegetative organs of plant and in the peripheric volatile oil canals of fruit aldehyde-containing volatile oil develops while linalool-containing volatile oil is formed only in the inner ducts of fruit.

Introduction

It is a well-known fact that the green coriander is of a disagreeable smell similar to that of the stinkbug; the name coriandrum is also derived from the Greek "koris" = stinkbug (HALMAI—NOVÁK 1963), while the volatile oil of the ripe fruit smells sweet. In general, literary data agree on the findings according to which volatile oil composition changes during the vegetation period (SCHIMMEL *et al.* 1895 KOPP 1928, TSHERNUHIN 1928, cit. GILDEMEISTER 1961, LŐRINCZ, TYIHAK 1965) there are, however, contradictory data, verifying that the quantity and quality of the coriander oil do not change at the different stages of development (IVANOV, GRIGOR'EVA, ERMAKOV 1929, cit. GUENTHER 1950).

The oil of the blooming coriander has been studied by CARBLOM (1936), who has stated it to be composed mainly of aldehydes. Aldehydes have been by way of preparative process produced from the volatile oil of green plant by REISCH, SCHRATZ, QADRY (1966) who have recently given account on the identification and synthesis of tridecen-(2)-al(1) (REISCH, SCHRATZ, QADRY, 1966).

The volatile oils of the ripe fruit are chiefly formed of linalool. Recently several experts have studied the fruit by way of thin-layer chromatography, such as: HÖRHAMMER *et al.* (1964) as well as BETTS (1964) especially with the view to distinguish it from other *Umbelliferae* fruit also being made use of in therapy, — or they have made comparative studies with different coriander varieties (SCHRATZ—QADRY 1966). Others, like e.g. LŐRINCZ—TYIHAK (1965), EL-HAMIDI—AHMED (1966) have studied the volatile oil of the plant during the vegetation period.

The researchers tried to find an explanation for the reason why the volatile oil composition of plant was changed. TSHERNUHIN (1928, cit. GILDEMEISTER 1961) has come to the conclusion that first the carbonyl group is being synthesized, then it is transformed into aldehyde which then continues to be reduced to alcohol (linalool) and partly to hydrocarbon. On the other hand TANASENKO (1960) says that in the two kinds of volatile oil canal (periferial and internal) of fruit two kinds of volatile oil develop: in the outer one more oxidized compounds while in the inner one mainly alcohols and hydrocarbons. According to HOTIN's (1957) data when fruit ripens at lower temperature and at higher humidity, the outer canals will remain and then oil yield will also be higher, although its quality is inferior. LUK'JANOV—MUHANOVA (1964) are as well of the opinion that the latter statements are pertinent.

BOROTYŃSKA (1956) studied the development of the volatile oil canals in the vegetative and reproductive parts of plant during the vegetation period. He traced aldehydes by Schiff reagent and remarks that in the root secondary volatile oil canals can only be discerned from the phloem cell by histochemical reaction; still he cannot tell, whether the reaction in the volatile oil canals of fruit remains positive all the time.

In our previous publication (LASSÁNYYI—LŐRINCZ 1967) we reported on the volatile oil of the coriander seedling not containing linalool; it has been stated that the volatile oil of fruit does not change during germination, neither is it used up.

In our present paper we deal with the problem how the composition of coriander volatile oil changes in the course of vegetation period and how these changes can histochemically be explained.

Materials and Method

The material of these examinations invariably was the coriander variety "Lucs" which has high volatile oil content and had been grown at the Budakalász Experimental Station of the Scientific Research Institute for Medicinal Plants. Sowing was performed in best weather in March with a row space of 40 cm. No considerable damage was done by insects neither has disease interfered with the experiment.

The time of gathering and the specification of the test material are shown in Table 1.

Sampling has always been made in the same time between 8 and 9 a. m. and the working up of it started as early as 10 a. m.

A) Thin-layer chromatographic examination of the volatile oil

A) The fresh material was rinsed with water and then blotted with filter-paper. From 1 to 4 they were ground to a pulp with the aid of glass-powder, from 5 to 13 the seedlings having been bigger already, were milled and from 14 on, they were cut into pieces of 1.5—2 cm. Up to the beginning of budding (8) the whole plant was distilled, then the umbels of the plant were separated from the other parts, and oil was distilled separately in each case, however, only the volatile oil of the main umbels was used for the examinations. In the case of 24, the fruit and the receptacle were distilled separately. The chopped parts of plants were distilled with a

Table 1

Dates and serial numbers of the material

No.	Date of sampling	Developmental stage of the plant
1.	IV. 8.	With two cotyledons
2.	IV. 15.	With one foliage leaf
3.	IV. 22.	With two foliage leaves
4.	IV. 29.	With three foliage leaves
5.	V. 6.	With four foliage leaves and one leaflet
6.	V. 11.	With five foliage leaves and one leaflet
7.	V. 20.	Shooting up, the cotyledons begin to wilt
8.	V. 24.	Budding, the cotyledons are dried
9.	V. 27.	Flowering begins
10.	VI. 3.	
11.	VI. 7.	The main umbel is in full bloom
12.	VI. 10.	The plant is in full bloom
13.	VI. 14.	The formation of the green fruit in the main umbel
14.	VI. 20.	The formation of the green fruit in the 1, 2, 3 branchings
15.	VI. 23.	The main umbel is yellowish-green
16.	VI. 28.	
17.	VII. 1.	
18.	VII. 5.	The lateral umbels begin to get yellow
19.	VII. 8.	
20.	VII. 12.	
21.	VII. 15.	The lower leaves begin to get yellow, the fruit of the main umbel begins to ripen
22.	VII. 19.	Half of the plant is partly dried, 20% ripe fruit
23.	VII. 22.	The plant is dried in 90%, the ripe fruit is 70%
24.	VII. 28.	The plant is dried, the fruit is ripe.

Clevenger glass distilling apparatus for two hours, then the volatile oil was diluted with benzene for being used for chromatographic examinations. The distilled volatile oil was studied partly qualitatively by STAHL (1962), LŐRINCZ—TYIHAK (1965) and partly quantitatively (linalool) by LASSÁNYI (1965). With all three methods the Kiesel G "Merck" layer (STAHL 1962) was prepared in the usual manner.

1. Solvent: benzene/ethylacetate (98 : 2).
Length of run: 15 cm
Spray reagent: hydrochloric acid solution of 2,4-dinitrophenyl-hydrazine
Drying: At room temperature
2. The solvent and the length of run are identical with the above
Spray reagent: 1% vanillin in concentrated sulphuric acid
Drying: At 105 °C for 10 minutes
3. Of the oil solution drops of identical concentration were applied on a plate, while those of the linalool were of increasing concentration as suggested by STAHL (1962)
Solvent: Benzene
Length of run: 10 cm

After drying, the plates were bromized for 3—5 minutes, then heated with a heat radiator for half an hour. The obtained spots were measured with a pattern made of synthetic material, and were graphically demonstrated in a manner that the values of concentration, as gained with the pattern, should be delineated on the abscissa while those of the linalool solution on the ordinate.

B) Histochemical examinations

For the histochemical studies fresh material has been used, and the sections were made according to Lassányi's method (1967). The sections were produced, with freezing microtome, from young plants being very sapful yet; as auxiliary material mucilago gum-arabic was used. When wood formation proceeded we made freehand sections. As aldehyde reagent the hydrochloric solution of 2,4-dinitrophenyl-hydrazine was applied; in such cases brown-coloured crystallic precipitate is being formed in the volatile oil canals that hold aldehyde-containing oil. Ligneous cell walls are stained rusty by the reagent.

Results and Discussion

One of the present authors (LŐRINCZ—TYIHAK 1965a) had observed the change in the volatile oil composition in the vegetative parts of coriander during ontogenesis. In the course of thin-layer chromatographic studies, linalool had been evinced also in the seedling. Later we established (LASSÁNYI—LŐRINCZ 1967) histochemically and by way of repeated lay-chromatography that the aforesaid linalool came from fruit-remains and not from the seedling. Therefore, it deemed to be necessary to study, just as well histochemically, the formation of the volatile oil and linalool in the course of ontogenesis.

Since it has been repeatedly established that the volatile oil of the green plant mainly consists of the mixture of aldehydes, we have used in our histochemical studies 2,4-dinitrophenyl-hydrazine this being suitable for evincing aldehydes. Volatile oil in the volatile oil canals of the root, shoot and floral axis, has shown positive aldehyde reaction in all developmental stages. Our observations show good agreement with those of BOROTYŃSKA (1956), viz., that though volatile oil canals are growing flattened in the course of development, they produce volatile oil even when the fruit is ripe already. In fact the volatile oil of the root reacts quickly in the volatile oil canals when applying 2,4-dinitrophenyl-hydrazine. In the stem there is much more volatile oil at the beginning than later. With the progress of drying processes the volatile oil canals become flattened and oil drops can be found in them but scarcely, however, even these produce, all the time, the aldehyde reaction. In the wall of the ovary and of the green fruit respectively, two kinds of volatile oil canals come generally into being (Figs 1, 2). BOROTYŃSKA has already established that the volatile oil canals being on the outer side of the mericarp are just like those being in the other parts of the plant. Really, there develops a precipitate with 2,4-dinitrophenyl-hydrazine in them. On the other hand, the volatile oil of the 2—2 dead-ended canals of the mericarps, which are on the inner, flat side of the mericarps, is not from the first producing aldehyde reaction. In the

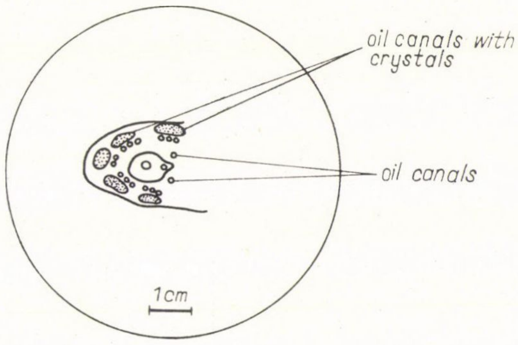


Fig. 1. **Scheme of half ovary of coriander**

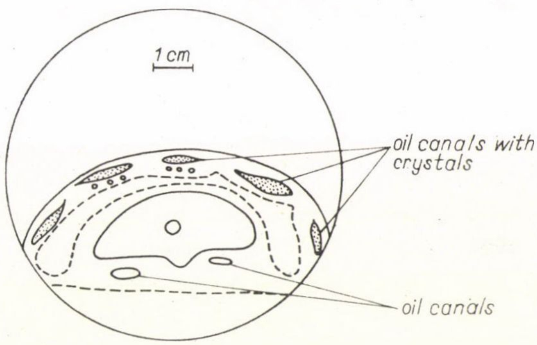


Fig. 2. **Scheme of half fruit of green coriander**

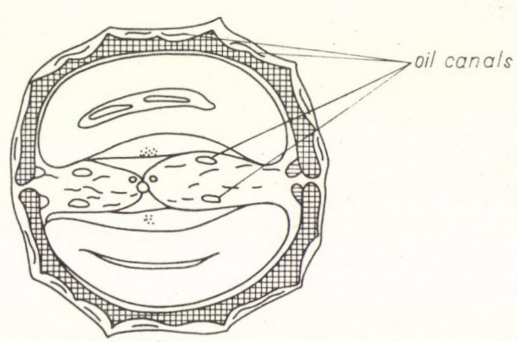


Fig. 3. Scheme of ripe fruit of coriander. (According to TSCHIRCH)

course of fruit development, the inner canals continue to develop for a time, then their size does not change any longer. In the time of fruit-ripening the outer canals are being thoroughly flattened (Fig. 3) and by dropping their content no more precipitate can be separated under the influence of the reagent. The flattening of the canals is basipetallic. At the beginning of the ripening of the main umbel the reaction is only positive in the lower part of the fruit, while with the side-umbels the whole fruit shows reaction. When 90 per cent of the plant is dried up (23), no more precipitate is formed in the fruit of the main umbel as a result of 2,4-dinitrophenyl-hydrazine treatment.

The results obtained with layer chromatography are in good agreement with histochemical observations. The volatile oil of the seedling consists of two

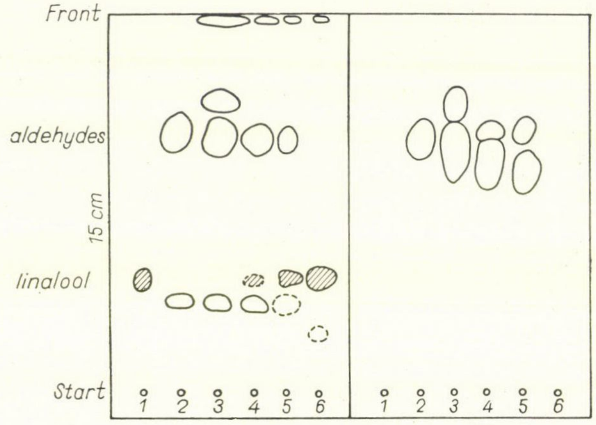


Fig. 4. Thin-layer chromatogram. Spray reagent: 1% vanillin in concentrated sulphuric acid
Fig. 5. Thin-layer chromatogram. Spray reagent: 2,4-dinitrophenyl-hydrazine
1. Standard linalool, 2. oil of seedling, 3. oil of plant at shooting up stadium, 4. oil of plant at flowering stadium, 5. oil of green fruit, 6. oil of ripe fruit

main components; one of them produces aldehyde reaction and this is present in a larger quantity, the other does not produce the aldehyde reaction. This material, being developed with concentrated vitriolic vanillin, will produce a blue spot (Figs 4, 5). The volatile oil of coriander without flower or fruit has contained, besides the component giving the initial aldehyde reaction, two components from shooting to the very last, however, the proportion of these is changeable. By the time the plant is dried up, they occur in almost the same quantity. The component being of non-aldehyde character, is present throughout the whole vegetation period. In the distilled volatile oil of these fresh plant parts no linalool could be evinced.

Quite different is the situation in the volatile oil of flower and fruit. Linalool can be observed as early as from the time of flowering. According to method 2, there appears above the blue spot a small lilac coloured spot; its Rf agrees with that of the linalool. In the course of development this grows gradually, while the blue spot is decreasing and is then finished up with disappearing (20). From this time on the linalool content of the fruit becomes steady. The aldehyde component of the volatile oil will remain though its quantity decreases gradually. By the time the half of the plant is partly dried up (22), that can be evinced in traces only, and in ripe fruit not even in traces (Figs 4, 5).

In case the fruit had been distilled together with the axis, aldehydes could be evinced in traces even at that phase, however, when distilling was done separately, aldehydes could be found in the volatile oil of the axis only.

As can be seen, our investigations support the hypothesis of TANASENKO (1960), LUK'JANOV—MUHANOVA (1964), according to which in the coriander there are two kinds of volatile oil canals and the volatile oil developing in

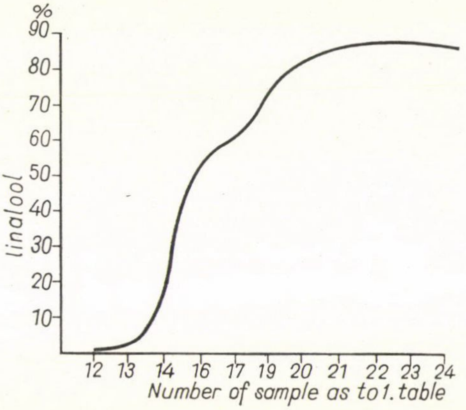


Fig. 6. Alteration of linalool content during vegetation period

them is different qualitatively, too. In the vegetative organs of the plant there are only such canals in which volatile oil is mainly composed of the mixture of aldehydes; on the other hand, the outer canals in the fruit are similar to those to be found in the other organs of the plant; their volatile oil is also of aldehyde content, however, the canals grow flattened at the time of ripening and lose their content. The inner canals of the fruit have a dead-end in it and they can be prepared out of the ripe fruit (BOROTYŃSKA 1956); volatile oil containing aldehyde is never produced in them. The fact that only the inner canals remain make the quality of the coriander volatile oil change during ripening.

Conclusions

Our investigations performed with histochemical methods have proved the coriander to have two kinds of volatile oil canals in which the composition of developing volatile oil is also divergent. The results obtained with thin-layer chromatographic investigations have supported the result of our histochemical observations. Volatile oil being present in the oil canals of the vegetative organ contains aldehydes, while in fruit volatile oil is of aldehyde content in the outer canals only; in the inner ones linalool is produced. Linalool content increases simultaneously with the development of the fruit. At the beginning this procedure is very quick and abrupt, later it slows down and, finally, it reaches a steady level (Fig. 6). In the course of ripening of the fruit the outer canals become flattened, they lose their content and do not produce aldehyde reaction any more. In the ripe fruit only the inner canals contain volatile oil the main component of which is linalool. That is the reason why the *Oleum Coriandri* contains 60—80 per cent of linalool.

REFERENCES

Betts, T. J. (1964): Umbelliferous Fruit Identification by Thin-layer Chromatography. J. Pharm. Pharmacol, **16,** Suppl. 131—135.

Borotyńska, W. (1956): Rozvój przewodów wydzielniczh w kolendrze siewnej (*Coriandrum sativum* L.). Biuletyn Panstwowego Instytutu Naukowego Leczniczych Surowców Roslinnych w Poznaniu, **2,** 13—23.

Carblom, A. J. (1936): J. prakt. Chem., **2,** 144—225. Cit. in Reisch, J.—Schratz, E.—Quadry, S. M. J. S. (1965).

El-Hamidi, A.—Ahmed, S. S. (1966): The Content and Composition of some Umbelliferous Essential Oils. Pharmazie, **21,** 7, 438—439.

Gildemeister, E.—Hoffmann, Fr. (1961): Die ätherischen Öle. VI. Akademie Verlag, Berlin.

Guenther, E. (1950): The Essential Oils. IV; D. Von Nostrad Co. Toronto, London, New York.

Halmai, J.—Novák, I. (1963): Farmakognózia. Medicina Könyvkiadó, Budapest.

Hotin, A. A. (Хотин, А. А.) (1957): Биологические основы аготехники, эфиромасл. культ. Диссертация, Краснодар.

Hörhammer, L.—Wagner, H.—Richter, G.—König, H. W.—Heng, I. (1964): 9. Mitt. Dünnschichtchromatographie von pharmazeutisch verwendeten Umbelliferen-Ölen. Dtsch. Apoth.-Ztg., **104,** 1398—1402.

Ivanov—Grigor'eva—Ermakov (1929): Bull. Applied Botany, Genetic. Plant Breeding USSR, **21,** 321. Cit. in Guenther (1950).

Kopp E. (1928): Pharm. Zentralh., **70,** 789, cit. Gildemeister (1961).

Lassányi, S. (1965): Approximate Quantitative Determination of Linalool in Coriander Oil by Way of Layer Chromatography. Acta Agr. Acad. Sci. Hung., **14,** 135—138.

Lassányi, Zs. (1967): The Histochemical Indication of Aldehydes in the Volatile Oil Canals of *Coriandrum sativum.* Acta Agr. Acad. Sci. Hung. **16,** 248—249.

Lassányi, Zs.—Lőrincz, K. (1967): Test on Terpenoids Present in Parts of *Coriandrum sativum* L. I. Thin-layer Chromatographic Examination of the Volatile Oil of the Pericarpium and Seedling of the "Lucs" Variety. Acta Agr. Acad. Sci. Hung., **16,** 95—100.

Lőrincz, K.—Tyihak, E. (Лёринц, К.—Тихак, Е.) (1965*a*): Исследование состава терпенов у кориандра (*Coriandrum sativum* L.) за время вегетационного развития растений. Herba Hung., **4,** 193—208.

Lőrincz, K.—Tyihak, E. (Лёринц, К.—Тихак, Е.) (1965*b*): Проблемы по определению эфиро масличности в селекции кориандра. Wiss. Ztsch. d. K. Marx Univ. Leipzig, **4,** 439—440.

Luk'janov, I. A.—Muhanova, M. M. (Лукьянов, И. А., Муханова, М. М.) (1964): Разнокачественность эфирного масла в плодах кориандра. Маслобойно—жировая пром **9,** 19—22.

Reisch, J.—Schratz, E.—Qadry. S. M. J. S. (1965): Trans-tridecen (2)-al(1) die Geruchsbestimmende Komponente des Corianders im vegetativen Stadium. Naturwiss., **52,** 642.

Reisch, J.—Schratz, E.—Qadry, S. M. J. S. (1966): Die Zusammensetzung des ätherischen Öles in den Früchten und der lebenden Pflanzen von Coriandrum sativum. II. Identifizierung und Synthese des Tridecen-(2)-al(1). Planta Med., **14,** 326—336.

Schimmel et Co. (1895): Ber. Schimmel Oktober, 12. Cit. in Gildemeister (1961).

Schratz, E.—Qadry, S. M. J. S. (1966): Die Zusammensetzung des ätherischen Öles in den Früchten und in den lebenden Pflanzen von *Coriandrum sativum* L. I. Untersuchung des Fruchtöles. Planta Med., **14,** 310—325.

Stahl, E. (1962): Dünnschicht-Chromatographie. Ein Laboratoriumshandbuch. Springer Verlag, Berlin, Göttingen, Heidelberg.

Tanasenko, F. S. (Танасенко, Ф. С.) (1960): О сушке семян кориандра перед хранением и переработкой, в связи с некоторыми их биологическими особенностями (диссертация). Краснодар.

Tshernuhin, A. M. (Чернухн, А. М.) (1928): Маслобойноширововое дело **12,** 34 Cit. in Gildemeister (1961).

Acta Agronomica Academiae Scientiarum Hungaricae Tomus 17 (1—2), pp. 223—229 (1968)

EFFECT OF HEAT TREATMENT AND ANAEROBIC HYDRATION ON THE RADIO-SENSITIVITY OF PEAS

By

A. BÁLINT, A. MEHANDGIEV, J. SUTKA

DEPT. OF PLANT BREEDING, COLLEGE OF AGRICULTURE, GÖDÖLLŐ

In order to study how the mutation process can be controlled, the air-dried seeds of *Petit Provençal*, a table pea variety, were kept in a drying chamber at a temperature of 60 ± 1° C for 24 hours, then they were treated with an 8,000 r and 11,000 r dose of X-rays. After irradiation we carried out anaerobic hydration at a temperature of 50 ± 1° C. The hydration following the heat treatment and irradiation increased the relative percentage of germination of the seeds and the average length of seedlings. The temperature and the anaerobic conditions in mitotic cells reduced the frequency of anaphases with chromosome bridges and fragments. As the result of the cumulative effect of the two factors less chromosome aberrations could be observed with an 11,000 r dose of X-rays than with a dose of 8,000 r when the seeds were untreated with secondary factors.

Introduction

The study of the physiological and genetical effects of radiation is one of the important links in controlling the mutation process. In recent years geneticists and breeders studying mutations have mostly treated such topics as how to change the frequency of valuable mutations in proportion to the undesired physiological and genetical changes, the possibility of extending the mutation spectrum and whether different mutagens and doses have different effects on particular genes of the chromosome or not.

In the literature many studies have treated the physiological, cytological and genetical effects of radiation [DUBININ (1961), GAUL (1964), SPARROW (1961), SPARROW *et al.* (1964), SUTKA (1966)]. Among the effect influencing factors, the type of radiation, intensity and genetical composition of the plant (DNS content, ploidy level, heterozygosis, etc.) have been examined and at the same time relatively little data were available on the role played by the physiological factors in the mutation process. The earlier examinations performed on barley showed that soaked seeds were more sensitive to X-rays than the dormant seeds kept in laboratory conditions (SMITH 1958).

While studying the effect of temperature NILAN—KONZAK (1961) pointed out that radiation done on dry ice at the temperature of liquid air reduced the frequency of induced chromosome aberrations while the frequency of mutations among the sprouts remained unchanged or increased.

According to the experiments of CALDECOTT—NORTH (1961) pre-radiation heat treatment and post-radiation anaerobic hydration increase the length of barley seedlings in the control given in percentage.

In general the increase of the radiation dose is in direct proportion to the increase of the frequency of chromosome aberrations which is manifest in the M_1 generation by growth and development inhibition and by extensive sterility. It would be useful to employ such a mutagenic treatment that allows for the increase of mutagene doses while keeping the chromosome aberrations on a low level (NILAN *et al.* 1961). Thus it is possible that with the increase of frequency in gene mutations the reduction of chromosome aberrations is attainable as well (SINGLETON 1962).

In the present study we shall treat the role of anaerobic hydration following X-ray and heat treatment in certain physiological and cytological changes.

Material and Methods

We have selected for our experiment *Petit Provençal*, a table pea variety. Before treatment the seeds were selected according to size and shape so that the deviation of the individuals participating in the experiment should be reduced to the smallest degree. In several previous experiments we discovered that pea seeds kept for 24 hours at a temperature of 60 $\pm$ 1° C and then subjected to a hydration of 45 minutes duration at 50 $\pm$ 1° C were more adapted to withstand serious damage.

As treatment 200 air-dry seeds were put into a drying chamber at a temperature of 60 $\pm$ 1° C. After 24 hours of heat treatment one part of the seeds was subjected to X-rays and the other one was used as unradiated controls. A few minutes after irradiation we performed the aerobic and anaerobic hydration. By the post-radiation treatment we attempted to reduce the relative quantity of oxygen. In order to realize this we simultaneously employed two factors: partly less oxygen dissolved in warm or boiling water than in water of 20° C and partly, for 45 minutes we piped nitrogen from a tank fitted with a thermometer on a rubber pipe into the Erlenmeyer flask placed in the water bath so that the seeds should be suspended in the water by the flow of nitrogen. Aerobic hydration differed from the anaerobic in that the seeds in the flask were kept in water at a constant temperature of 50 $\pm$ 1° C for 45 minutes without a flow of nitrogen. The unradiated control variants were also subjected to aerobic and anaerobic hydration and even these seeds were soaked at 20° C.

We have used the X-ray apparatus of the Electron Microscope and X-ray Laboratory of the College of Agriculture. For assuring the radiation of the seeds in one layer they were imbedded in plasteline with the germ facing the ray source and plastic bags were used to protect the seeds against possible dampening. According to earlier experiences doses of 8,000 r and 11 000 r seemed useful for carrying out the described experiment. The physical conditions of irradiation were the following: KV—180, V—148, mA—15, focus: 50 cm, intensity: 26.7 r/min. The radiation room had a temperature of 26 $\pm$ 2° C and a relative humidity of 48%.

The treated seeds were germinated in Petri dishes on moist filter paper in a thermostatic chamber at a temperature of 23—24° C. Part of the germinated seeds was used for cytological examination and the other for raising on Knopp solution or for the measurement of growth intensity in flower pots in the greenhouse.

In order to study chromosome aberrations 1—2 mm were cut off the growing apex of the roots of 25—30 seeds of each treatment and these were fixed for 24 hours in Carnoy fixative. The fixed root apices were kept in 50% ethyl alcohol until the day of study. Before using fuchsine staining the root apices were hydrated for 12 minutes then squash preparations were made. We counted 50—60 anaphases in each preparation. We separately recorded the normal anaphases, as well as the cells containing anaphase bridges and fragment. The frequency of chromosome aberrations is given by the total value of the anaphases with bridges and fragments.

Results

Radiation in the M_1 generation has reduced the degree of germination and the longitudinal growth of the seedlings. A striking difference has been noted between the radiation doses while in case of both doses the combination of heat treatment and anaerobic hydration intensifies growth inhibited by radiation. According to Fig. 1 there is an insignificant difference between 8,000 r + aerobic hydration and 60° C + 11,000 r + anaerobic hydration. From this we can deduce that among optimal conditions of temperature and anaerobic

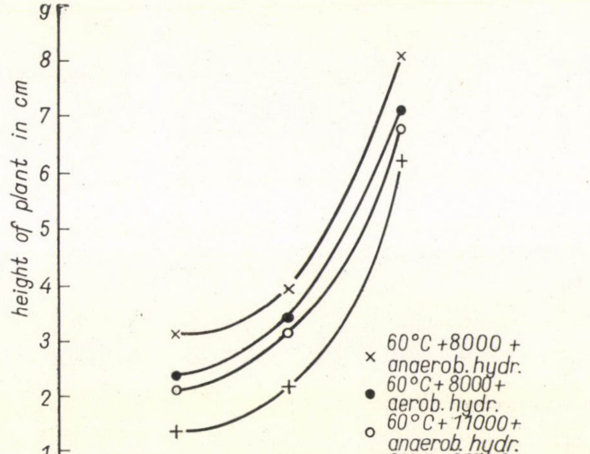
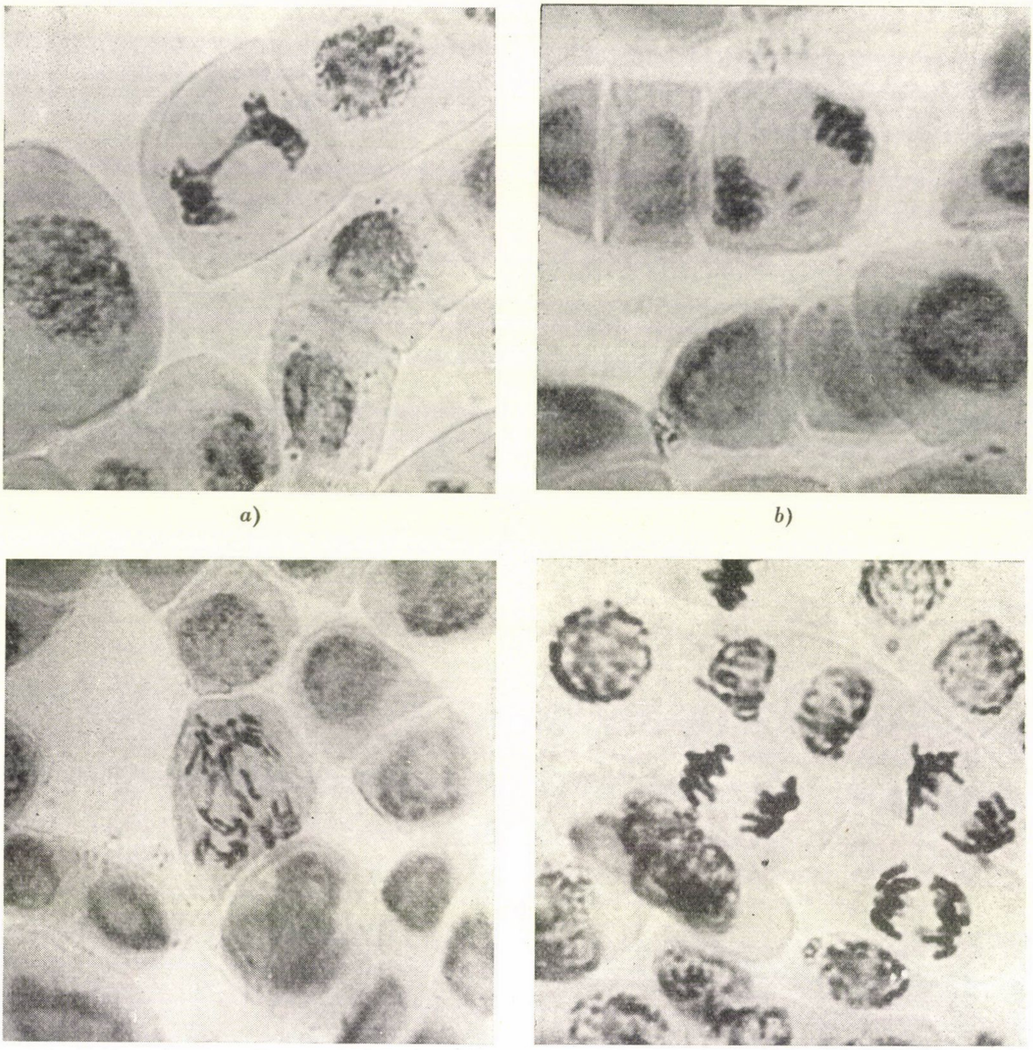


Fig. 1. The effect of heat treatment and anaerobic hydration on the longitudinal growth of shoots treated with mutagens

circumstances it is possible to increase the radiation dose without the corresponding inhibition of the longitudinal growth of seedlings.

Radiation can directly or indirectly break the chromosomes. During cell division centric chromatids containing centromeres and acentric chromatids not containing centromeres may arise. In case of isochromatid fragments with centromeres the adhesion of the aberrations of the chromatids occurs in the majority of the cells and this may unite the parting centromeres so that chromosome bridges can be formed in the subsequent anaphase. The acentric portion appears as a fragment in the anaphase of the dividing cells. Such aberrations of division can be seen in Fig. 2. Generally the percentage frequency of cells having anaphase bridges and fragments during division is in direct proportion to the increase of the radiation dose (Table 1).

The increase of chromosome aberrations very frequently results in the sterility of the plant since the meiotic process is also abnormal; viable gametes



a) b)

c) d)

Fig. 2. Types of chromosome aberrations examined: *a*) with anaphase bridges, *b*) anaphase with two fragments, *c*) anaphase with bridges and fragments, *d*) normal anaphases

are not formed. According to the cytological examinations the frequency of chromosome aberrations can be reduced by the appropriate combination of secondary factors. In all cases it can be seen from the radiated material that the anaerobic hydration has significantly reduced the frequency of anaphases with bridges. Anaphases with fragments can bring about undeniable changes in favour of anaerobic hydration only in case of an 11,000 r dose. The tendency of the effect of heat treatment is identical with that of anaerobic hydration. Table 1 also shows that the anaerobic hydration following heat treatment and

Table 1

Effect of secondary factors on the frequency of chromosome aberrations

No.	Treatment	Examined anaphases		Anaphase bridges		Anaphase fragments	
		No.	%	No.	%	No.	%
1.	60° C + 8,000 r + anaerobic hydr.	1700	100	52	3.06 ± 0.41	18	1.06 ± 0.24
2.	60° C + 8,000 r + aerobic hydr.	1947	100	103	5.35 ± 0.51	22	1.13 ± 0.24
3.	8,000 r + anaerobic hydr.	1968	100	126	6.40 ± 0.54	22	1.12 ± 0.23
4.	8,000 r + aerobic hydr.	1918	100	161	8.40 ± 0.63	27	1.40 ± 0.26
5.	60° C + 11,000 r + anaerobic hydr.	1744	100	107	6.15 ± 0.58	27	1.54 ± 0.27
6.	60° C + 11,000 r + aerobic hydr.	1470	100	119	9.00 ± 0.74	41	2.80 ± 0.42
7.	11,000 r + anaerobic hydr.	2112	100	204	9.70 ± 0.64	38	1.70 ± 0.25
8.	11,000 r + aerobic hydr.	1876	100	247	13.22 ± 0.78	69	3.70 ± 0.43
9.	60° C + unirradiated + anaerob. hydr.	1929	100	31	1.08 ± 0.23	8	0.41 ± 0.14
10.	60° C + unirradiated + aerob. hydr.	1978	100	72	3.64 ± 0.41	4	0.20 ± 0.31
11.	unirradiated + anaerob. hydr.	1882	100	51	2.76 ± 0.37	11	0.56 ± 0.17
12.	unirradiated + aerob. hydr.	1151	100	44	3.80 ± 0.55	7	0.50 ± 0.20
13.	unirradiated + 20° C soaking	1665	100	9	0.54 ± 0.17	6	0.36 ± 0.14
14.	60° C unirradiated	1880	100	84	4.41 ± 0.47	15	0.80 ± 0.20
					L. S. D. 5% = 2.0992 L. S. D. 1% = 2.7606		L. S. D. 5% = 1.176 L. S. D. 1% = 1.548

radiation has a cumulative effect on the frequency of chromosome aberrations. Among the unirradiated combinations — although with slighter differences — there appears a cumulative effect bringing about the reduction of chromosome aberrations. It should be noted that the preparations of unirradiated seeds at a temperature of 60° C result in a proportionally high percentage of cells with bridges (4.41 ± 0.47). The least amount of chromosome aberrations could be found among the unirradiated combinations soaked at 20° C.

During the cytological examinations it was most striking to find that less chromosome aberrations had resulted from the 60° C + 11,000 r + anaerobic hydration than from the 8,000 r + aerobic hydration. The difference is significant at 5 per cent. Thus with appropriate combinations of temperature and anaerobic conditions we could keep on the same level not only the frequency of chromosome aberrations but it could be reduced, in comparison to the 8,000 r, with a dose of 11,000 r. Fig. 3 demonstrates the results of the experiments in a complex way: there is a negative correlation between the frequency of chromosome aberrations and the length of seedlings or the relative percentage of germination.

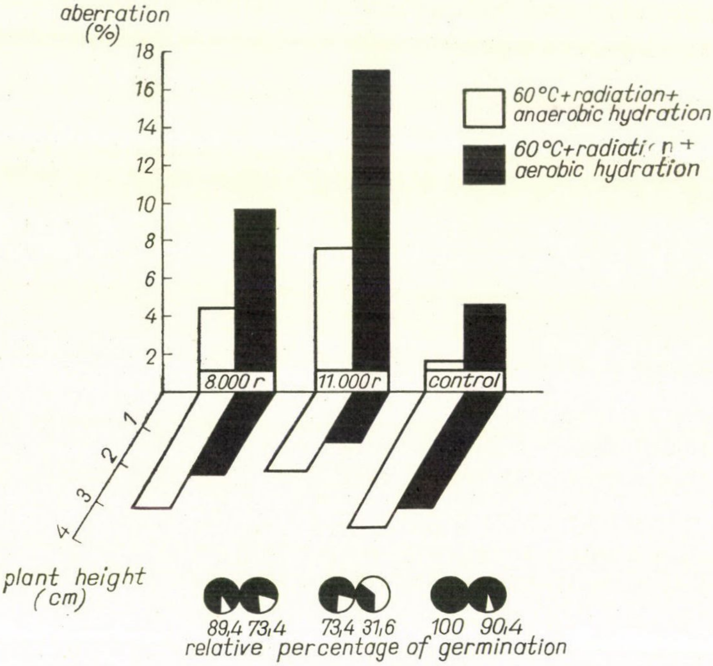


Fig. 3. The cytological and physiological effect of heat treatment and anaerobic hydration on peas treated with mutagens

Discussion

The key to the mechanism of mutation is the ionization of atoms by radiation. As the result of ionization the bonds of the DNS molecules break and so do the chromosomes. It must also be emphasized that ionization may not only occur in the DNS chain but due to radiation the water and oxygen always present in the living cell may be ionized. Organic peroxide radicals and compounds are formed which reacting with the DNS molecule result in chromosome fragments or change — indirectly — the sequence of DNS bases. Either the direct or the indirect effects are considered more important, the "delayed mutagenesis" theory of Dubinin (1965) can be agreed with. Accordingly the realization of chromosome mutation involves a chain process requiring a longer time. The mutagenes in the chromosome induce potential break which develops after a certain period of time into true chromosome fragmentation. The biological and chemical requirements of mutagene treatment, mostly the oxygen and water content, and the temperature, may decisively influence the described process viz. some potential chromosome breaks instead of resulting in true chromosome fragments which may revert to the original state. Presumably the 24-hour preradiation heat treatment at 60 $\pm$ 1° C has reduced the moisture content of the seeds and changed certain physiological processes (e.g. oxygen pressure was reduced in the cells). Anaerobic hydration after radiation set off important chemical processes in the presence of less oxygen, for both the warm water and the nitrogen forced through it have reduced the relative quantity of oxygen. It is probable that the conditions of anaerobic cell respiration have facilitated the return of the potentially broken chromosomes to the original chromosome structure. If anaerobic conditions are accompanied by water absorption oxygen tension has a permanent effect on making radiation damage being manifest in the microscopic structure of the chromosomes. The reduction of the damage caused by mutagenic treatment with the help of the combined effect of temperature and oxygen content could aid in the increase of radiation dose while keeping the chromosome aberrations relatively low. We still have to answer the question whether the applied method will decrease the frequency of vital gene mutations, polygenic mutations along with changes in the frequency of chromosome aberrations.

REFERENCES

Caldecott, R. S.—North, D. T. (1961): Factors Modifying the Radio-sensitivity of Seeds and the Theoretical Significance of the Acute Irradiation of Successive Generations. Symposium on Mutation and Plant Breeding, Washington, 363—404.

Dubinin, N. P. (Дубинин, Н. П.) (1961): Проблемы радиационной генетики. Гос. Атом. Издат. Москва.

Dubinin, N. P. (1965): Chain Process in Chemical and Radiation Mutagenesis. Symposium on the Mutational Process. Praha. Abstracts.

Gaul, H. (1964): Mutations in Plant Breeding. Radiation Botany, **4,** 155—232.

Nilan, R. A.—Konzak, C. F. (1961): Increasing the Efficiency of Mutation Induction. Symposium on Mutation and Plant Breeding. Washington, 437—460.

Singleton, W. R. (1962): Induced Mutations. Elementary Genetics, 300—337.

Smith, H. H. (1958): Radiation in the Production of Useful Mutations. The Botanical Review, **24(1),** 2—19.

Sparrow, A. H. (1961): Types of Ionizing Radiation and their Cytogenetic Effects. Symposium on Mutation and Plant Breeding. Washington, 55—119.

Sparrow, A. H.—Sparrow, R. C. *et al.* (1964): The Use of Nuclear and Chromosomal Variables in Determining and Predicting Radiosensitivities. Use of Induced Mutations in Plant Breeding. FAO—IAEA-Eucarpia. Rome.

Sutka, J. (1966): A mutációs elmélet és a mutánsok előállítási módszereinek fejlesztése (The Mutation Theory and the Development of Methods of Producing Mutants). Növénytermelés, **15,** 147—166.

Yamashita, A. (1964): Some Aspects of Radiosensitivity of Crop Plants under Chronic Exposure. Gamma Field Symposia, **3,** 91—108.

Acta Agronomica Academiae Scientiarum Hungaricae Tomus 17 (1—2), pp. 231—237 (1968)

CORRELATIONS BETWEEN LIVE WEIGHT OF THE COW AND ITS ABSOLUTE AND RELATIVE MILK PRODUCTION IN THE RED DANISH MILK BREED

By

J. DOHY, G. KELEMÉRI

INSTITUTE OF ANIMAL HUSBANDRY, UNIVERSITY OF VETERINARY MEDICINE, BUDAPEST

Correlations between live weight, absolute and relative milk production of Red Danish cows were examined on the basis of the data of 485 first lactations at the Danish progeny testing stations. Between live weight established after calving and absolute lactation yield (FCM) a significant correlation of $r = + 0.213$, between live weight and relative (related to 100 kg live weight) milk production $r = - 0.253$ and between absolute and relative milk production $r = + 0.832$ were found. It is suggested to include relative milk production among the viewpoints of selection of the dairy cattle.

Introduction

To increase economic efficiency of milk production it is of fundamental importance that between body size — as means of production — and production of the cow the most favourable ratio possible should subsist. The more optimal this proportion, that is the higher the milk production per unit of live weight (body mass), the less food for maintenance will be required for 1 kg of milk. Therefore, beyond the absolute milk production increasing attention should be paid to relative milk production as related to body weight. To the significance of the utilization of relative milk production as a viewpoint of selection attention was called especially by the results of population—genetic research. It has appeared, namely, that the heritability of live weight is generally higher than that of milk production (this statement particularly applies to the values of body dimensions characterizing body size, especially to the h^2 value of the height of withers). Thus when selection for breeding takes place without considering the body weight on the basis of the milk or milk fat produced there is a probability that body weight of the cow stock increases at a more rapid pace than its milk producing capacity and therefore the production related to the unit of live weight decreases. This, however, means an increase of the cost of fodder representing a very substantial quota in the cost of production of milk, as a consequence of the subsistence nutrient requirement per 1 kg milk.

KLEIBER—MEAD pointed out already in 1941 that it were desirable to conduct selection of the cows on the basis of their relative milk production. HORN (1963, 1965) also attracts the attention to the importance of the evaluation of relative production, pointing out that every live-weight surplus of

100 kg involves 160 kg starch-equivalent for maintenance per year. — The significance of the establishment and evaluation of relative milk production was recently illustrated by the examinations of DOHY—LUDROVSZKY (1965) according to which the relative milk production lends itself to the indirect expression of food-utilization in the progeny test of bulls.

From these follows the importance of the question what correlation exists between the live weight of the cow and its absolute as well as relative milk production. The statements found in literature on this subject are rather contradictory.* GOWEN (1924, 1925) on a population of cows of the Holstein-Friesian breed — taking the age for constant — found a correlation of $r = + 0.425$ between live weight and milk production. TURNER (1921, 1930) examined the correlation between lactation milk fat production and live weight in Guernsey and Jersey cows and found it to be of a value of $r = + 0.249$ or $r = + 0.114$ respectively. — According to JOHANSSON (1964) in these examinations — similarly to many others — it is an important source of error that the differences between the populations and the time trend of production and live weight were not eliminated. DAVIS—MORGAN—GAINES (1943) established a correlation of $r = + 0.41$ between live weight and milk production in the case when the live weight was established within a month after calving while the value of the correlation coefficient was only + 0.22 when the live weight was established 8 months after calving. JOHANSSON (1954) on Red Danish cows included in a progeny test (in the case of identical age) found a correlation of $r = + 0.197$ between the amount of milk fat produced during the first 250 days of lactation and the live weight. This examination also revealed that the increase of live weight during the first lactation had been in a negative correlation with the 250 day milk fat production. MILLER—MCGILLIARD (1959) on the basis of the analysis of American Holstein, Guernsey and Jersey stocks established a genetic correlation of + 0.3 between live weight and milk production. NIELSEN (1962) in the course of Danish progeny tests — in case of standardized age — found in the Red Danish and the Danish Black and White breed + 0.17, in Jersey + 0.24 correlation between the live weight and the FCM (standardized to 4 per cent fat content) production.

In contrast to the research workers referred to, TOUCHBERRY (1951), MASON—ROBERTSON—GJELSTAD (1957), BLACKMORE—MCGILLIARD—LUSH (1958), BREITENSTEIN—NÖRING (1960), NÖRING (1962) and CLARK—TOUCHBERRY (1962) did not find a significant correlation between live weight and milk production of cows.

In Hungary, in examinations conducted on Hungarian Spotted cows DUNAY—DOHY (1961) found between girth and lactation yield a correlation

* Since the present study deals with the relationships between live weight and production we generally dispensed with the publication of examination results in which the characterization of the body weight took place on the basis of certain body dimensions.

of r = + 0.208 (P<0.1 per cent), CZAKÓ—FERENCZ—BÁRCZY (1964) between live weight and lactation milk production + 0.32 (P<0.1%), SEBESTYÉN (1964) + 0.64 (genetical) or + 0.26 (phenotypical), KECSKÉS (1965) + 0.25 to + 0.30 correlation. — As a contrast, according to the examinations of BOZÓ—DUNAY (1966) on adult Hungarian Spotted and 50 per cent Jersey blood populations no correlation appeared between live weight and maximum lactation milk production when the relationship was established within herds on the same farm or in the case of nearly identical level of keeping and feeding.

The examinations referred to pointed for the most part to relationships between absolute milk production and live weight. Recently data pointing to relative milk production have also been multiplying. Correlation between live weight and relative milk production was found to be negative (r = —0.28) in the course of examinations conducted on Czech Spotted cows by SUCHÁNEK (1963). DOHY—DUNAY (1963) established between the lactation FCM production and the relative milk production a significant correlation of r = +0.864, between the girth and the index of relative milk production r = —0.395 on Hungarian Spotted cows. These examinations corroborate the earlier findings of FARKAS (1936) and HORN (1942) according to which in the Hungarian Spotted breed generally the relative milk production of cows of 550—600 kg live weight is the most favourable.

Material and Method

In order to promote selection by relative milk production it has been found necessary to examine what correlation can be established under optimum environmental conditions in a high producing breed:

1. between live weight and absolute (FCM) milk production of the cow;
2. between live weight and relative milk production;
3. between absolute and relative milk production.

The elucidation of these correlations is of basic importance for establishing the effectiveness of selection.

Examination was conducted on the basis of the data of 1818 daughters of 102 bulls of the Red Danish breed progeny tested in Denmark on progeny testing stations (NIELSEN 1963, 1964) in 1961/62 and 1962/63. To eliminate the source of error arising from the differences of the age at the first calving only those individuals had been taken into consideration the age of which at calving fell between 900 and 960 days. Thus the data on 485 first lactations were available for elaboration. To express the absolute milk production the FCM production during the progeny test and to express relative milk production the FCM production related to 100 kg live weight were used. Live weight was established after calving.

Results and Discussion

The results of correlation and regression calculations is condensed in Table 1.

Figs 1 and 2 serve to illustrate the correlation between live weight and absolute milk production, further between live weight and relative milk production.

On the grounds of the experimental results the following statements can be made:

1. Between live weight established after calving and absolute FCM production of first lactating Red Danish cows a modest positive correlation has

Fig. 1. Representation of the relationship between live weight and absolute FCM production

Table 1

Comprehensive table of the results of correlation and regression calculations

Characters	Correlation coefficient	Significance	Regression coefficient
Live weight—absolute FCM-production	+0.213	P < 0.1%	+487 kg*
Live weight—relative milk production	−0.253	P < 0.1%	−119 kg**
Absolute FCM-production—relative milk production	+0.832	P < 0.1%	+ 16.9 kg***

* Increase of live weight by 100 kg increased the absolute FCM production by 487 kg

** Increase of live weight by 100 kg reduced the relative milk production (related to 100 kg live weight) by 119 kg

*** 100 kg increase of the absolute FCM production was accompanied by 16.9 kg increase of relative milk production.

appeared which according to the results of calculated regression means that in this population producing 5200 kg FCM on the average under optimum environmental conditions 100 kg increase of live weight was followed by 487 kg average increase of FCM production.

2. Between live weight and relative milk production a definite negative correlation has appeared which according to the results of regression calculation manifests itself in that the increase by 100 kg of the live weight was accompa-

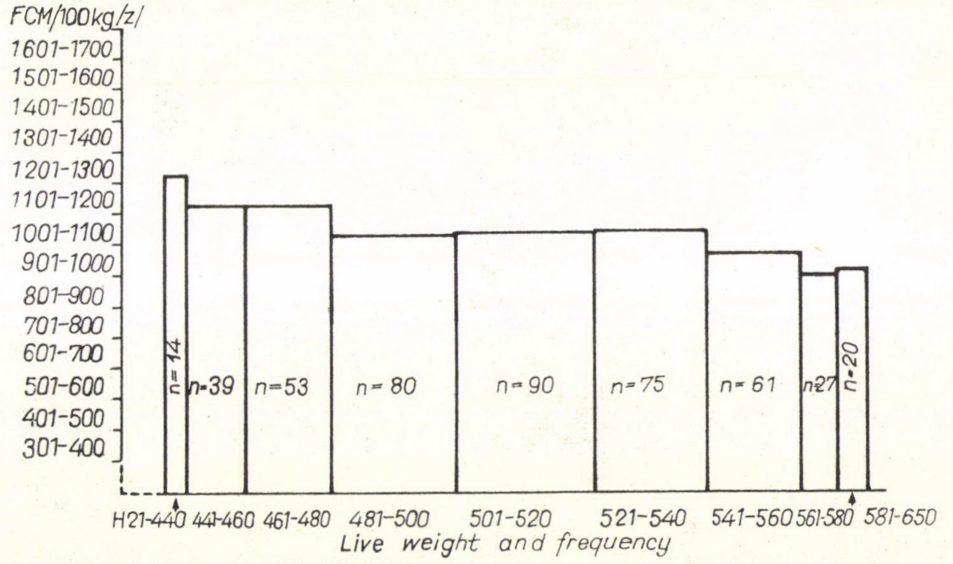


Fig. 2. Representation of the relationship between live weight and relative milk production (FCM: 100 kg)

nied by a 119 kg reduction of the relative milk production (related to 100 kg live weight). This means that in the livestock examined *100 kg increase of live weight was accompanied by a 12 per cent reduction of relative milk production on the average.*

3. The very close positive correlation established between absolute and relative milk production points to the fact that on the basis of relative milk production an effective selection could be conducted also in the interest of increasing the absolute milk production.

Inclusion of relative milk production among the points of selection in dairy cattle is justified also by the results of the present examination.

Conclusions

Correlations between live weight, absolute and relative milk production of the cow were examined on the basis of the data of 485 first lactating cows of the Red Danish breed on the Danish progeny testing stations. The age at first calving of the livestock involved in the examination was between 900 and 960 days. Between the live weight measured after calving and the absolute lactation FCM production a significant correlation of $r = +0.213$, between the live weight and the relative milk production (related to 100 kg live weight) $r = -0.253$ and between absolute and relative milk production $r = +0.832$ were found. On the basis of experimental results obtained and statements found in special literature authors suggest to include relative milk production among the points for selection of dairy cattle.

REFERENCES

Blackmore, D. W.—McGilliard, L. D.—Lush, J. L. (1958): Relationships Between Body Measurements, Meat Conformation, and Milk Production. J. Dairy Sci., **41**, 1050—1056.

Bozó, S.—Dunay, A. (1966): Testtömeg és tejtermelés közötti összefüggés vizsgálata a kifejlett teheneken (Examination of the Relationship Between Body Weight and Milk Production on Adult Cows). Állattenyésztés, **15**, 207—213.

Breitenstein, K. G.—Nöring, L. (1960): Untersuchungen über Beziehungen zwischen Körperformen und Leistungen beim Höhenfleckvieh. Tierzucht, **14**, 397—400.

Clark, R. D.—Touchberry, R. W. (1962): Effect of Body Weight and Age at Calving on Milk Production in Holstein Cattle. J. Dairy Sci., **45**, 1500—1510.

Czakó, J.—Ferencz, G.—Bárczy, G. (1964): Magyartarka bikák tenyészérték-becslésének alakulása utódaik első, illetve második laktációs eredményéből számítva (Development of the Breeding Value Estimation of Hungarian Spotted Bulls as Calculated from the First or Second Lactation Result of the Progeny). Állattenyésztés, **13**, 1—16.

Davis, H. P.—Morgan, R. F.—Gaines, W. L. (1943): Live Weight and Milk-energy Yield in the Nebraska Station Dairy Herd. J. Dairy Sci., **26**, 625—641.

Dohy, J.—Dunay, A. (1963): A relatív tejtermelés vizsgálata magyartarka teheneken (Examination of Relative Milk Production on Hungarian Spotted Cows). Állattenyésztés, **12**, 129—135.

Dohy, J.—Ludrovszky, F. (1965): A relatív tejtermelés és a takarmányértékesítés összefüggésének vizsgálata dán vörös fajtájú ivadékcsoportokon (Examination of the Relationship Between Relative Milk Production and Fodder Utilization on Progeny Groups of the Danish Red Race). Állattenyésztési Kutató Intézet Évkönyve, **3.**

Dunay, A.—Dohy, J. (1961): Az élősúly, az övméret és a tejtermelés összefüggésének vizsgálata magyartarka teheneken (Examination of the Relationship Between Live Weight, Girth and Milk Production on Hungarian Spotted Cows). Állattenyésztés, **10**, 7—12.

Erb, R. E.—Ashworth, U. S. (1961): Relationships Between Age, Body Weight and Yield of Dairy Cows. J. Dairy Sci., **44**, 3.

Farkas, T. (1936): Szarvasmarhatenyésztési problémák biometriai megvilágításban (Problems of Cattle Breeding in a Biometrical Light). Diss., Budapest. Szerzői kiadás. (Ed. by the autbor.)

Gowen, J. W. (1924): Milk Secretion. Baltimore, Williams and Wilkins Co. 636.

Gowen, J. W. (1925): The Size of the Cow in Relation to the Size of her Milk Production. J. Agric. Res., **30**, 865—869.

Horn, A. (1942): Újabb irányelvek a szarvasmarhatenyésztésben (New Guiding Principles in Cattle Breeding). Budapest, Pátria.

Horn, A. (1963): A szarvasmarha értékmérő tulajdonságainak fejlesztése, a fajták és keresztezések értékelése az alkalmazott genetika tükrében (Development of the Standard Qualities of Cattle, Evaluation of Breeds and Crosses as Reflected by the Genetics Applied). Időszerű kérdések a szarvasmarhatenyésztés köréből. Mezőgazdasági Kiadó, Budapest.

Horn, A. (1965): The Application of Modern Genetic Principles in Order to Render the Production of Hungarian Spotted Cattle More Economical. Acta Agr. Acad. Sci. Hung., **14**, 155—177.

Johansson, I. (1954): An Analysis of Data from the Danish Bull Progeny Testing Stations Z. Tierz. Zücht. Biol., **63**, 105—126.

Johansson, I. (1964): The Relation Between Body Size, Conformation and Milk Yield in Dairy Cattle. Anim. Breed. Abstr., **32**, 421—433.

KECSKÉS, S. (1965): A magyartarka fajta típusát megszabó tulajdonságok vizsgálata a szelekció érdekében (Examination of the Characters Determining the Type of the Hungarian Spotted Breed in the Interest of Selection). Állattenyésztési Kutató Intézet Évkönyve, **3.**
KLEIBER, M.—MEAD, S. W. (1941): Body Size and Milk Production. J. Dairy Sci., **24,** 127—134.
MASON, I. L.—ROBERTSON, A.—GJELSTAD, B. (1957): The Genetic Connexions Between Body Size, Milk Production and Efficiency in Dairy Cattle. J. Dairy Res., **24,** 135—143.
MILLER, R. H.—McGILLIARD, L. D. (1959): Relations Between Weight at First Calving and Milk Production During the First Lactation. J. Dairy Sci., **42,** 1932—1943.
NIELSEN, E. (1962): Afkomsprøver med tyre 1945—60. København, Stat. Husdyr.
NIELSEN, E. (1963): Afkomsprøver med tyre XVII. København, Stat. Husdyr.
NIELSEN, E. (1964): Afkomsprøver med tyre XVIII. København, Stat. Husdyr.
NÖRING, L. (1962): Untersuchungen über Körperentwicklung und Leistungen von Schwarzbunten Niederungsvieh in der Höhenlage unter Berücksichtigung verschiedener Haltungsformen bei optimalen Aufzuchtbedingungen. Arch. Tierz., **5,** 251—280.
SEBESTYÉN, G. (1964): Genetikai korrelációk a fajtatiszta tenyésztés szolgálatában (Genetic Correlations in the Service of Breeding of Varietal Purity). Állattenyésztés, **13,** 2.
SUCHÁNEK, B. (1963): Vztah mezi mlécnou uzitkovosti a zivou váhou krav. Ziv. Vyroby, **8,** 389—398.
TOUCHBERRY, R. W. (1951): Genetic Correlations Between Five Body Measurements, Weight, Type and Production in the Same Individual Among Holstein Cows. J. Dairy Sci., **34,** 242—255.
TURNER, C. W. (1929): The Relation Between Weight and Fat Production in Guernsey Cattle. J. Dairy Sci., **12,** 60—73.
TURNER, C. W. (1930): The Inheritance of Body Weight in Relation to Milk Secretion. Res. Bull. Mo. Agric. Exp. Sta., **147,** 42.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 239—243 (1968)

SOME INVESTIGATIONS ON WHEAT AT MARTONVÁSÁR*

By

S. RAJKI

AGRICULTURAL RESEARCH INSTITUTE OF THE HUNGARIAN ACADEMY OF SCIENCES, MARTONVÁSÁR

This publication comprises two of the four themes on which a lecture was delivered at the wheat breeding symposium held in Krasnodar: these are the autumnization genetics and the vernalization biochemistry. The relationship and mutual effect of the researches carried out in these two fields for more than ten years, are then treated here.

1) For twelve years autumnization-genetical investigations have been carried out with the view to control whether there might develop a genetical change under the influence of the environment. Briefly: whether spring wheat can be converted into winter wheat. These investigations have been based on the hypothesis that the results might provide information for the problems how heredity is to be interpreted and how the relationship of metabolism and heredity can be explained.

I was aware well enough of the fact that the work to be done was not an easy one. The actual task of investigation, i.e. the autumnization as a performance of inheriting the acquired properties, in other words: the experimental control of the "Lamarckian phenomenon" was — by the majority of geneticists — considered as heresy or, at least, some useless effort about a stale problem that had been decided upon long ago. And yet, I could not disregard the experimental control, so deep was I interested in the truth about that much-discussed problem.

Almost twelve years have passed since that time. Three autumnization cycles, of several years each, have been carried out. On the results of the experiments papers have been prepared (RAJKI 1962, 1963, 1965, 1966*a*, 1966*b*, 1966*c*) and lectures delivered at international scientific conferences.

At the end of the last year I presented my Academic Doctor's dissertation the text of which is going to be published in these days by the Hungarian Academy of Sciences in English under the title: "Autumnization and its Genetic Interpretation" (RAJKI 1967).

In its structure, the dissertation reflects the course of the autumnization investigations carried out in Martonvásár. The test crosses being dominant in the first years' experimental program, became later considerably complemented by physiological, biochemical and cytological examinations. The evaluation of

* A lecture delivered by the author at the wheat breeding symposium in Krasnodar on 15th June, 1967.

the results required the raising of the basic genetical-theoretical problems and also their being answered as far as it was possible for us. This was written about in the booklet with the title "On the Situation in Genetics" that appeared last spring (RAJKI 1966*c*).

On the basis of summing up — in this booklet — the literature opposing one of the general principles of molecular gene concept i.e. CRICK's "central dogma" and the facts of our own autumnization genetical examinations proving the inheritance of acquired properties, i.e. the "Lamarckian phenomenon", we are in the position to render likely the feed-back, the bilateral, reversible transfer of information. At the same time we formulate the metabolic-biochemical conception (e s s e n t i a l l y that of MICHURIN) of heredity. According to this the most direct way to understand and control heredity is by a thorough and manifold disclosure of the biochemistry of metabolism.

The "post mortem science" argument that — among others — might be alleged against the concept, is counterbalanced by the fact that our conclusions have been drawn on the basis of comparing and considering the results of manifold (morphophysiological, physiological and biochemical, cytological, genetical, etc.) investigations. Thus, I hope to avoid the obstacles expressed in CHARGAFF's (1963) well-known thesis accepted by us, too, according to which: "Life is what's lost in the test tube".

Relying upon the results obtained so far in our autumnization genetical investigations, we have tried (RAJKI 1967) to draft a hypothetical model and the "biochemical mechanism" of autumnization.

The basic idea behind the hypothetical mechanism and model is that of interpreting living body or the unity of the non-living but viable body with its life conditions as a multi-leveled metabolic formation. The order of the metabolic levels is as follows: 1) assimilation system (in a wider sense, the primary recipient system of the environmental effects), 2) proteins, 3) nucleic acids, expressing also the increasing rate of stability and, buffering from the effects of environmental factors.

The various environmental active agents exert or may exert their effects up to different metabolic levels. Some of them may reach the stablest level, the most buffered one from/by the previous levels and the result of interaction may manifest in a change in the nucleotid sequence.

Finally, the change taking place in the life conditions of the organism, that is, in one side of the dialectical unity of the non-living but viable body with its life conditions, may result in inheritable change of the organism. Under the effect of autumn cropping the environment has been changed and in accordance with the quality and quantity of environmental change, spring wheat transforms into winter wheat: that is, autumnization is achieved.

Autumnization, the adequate gradual transformation in the genetically pure spring initial stock (RAJKI 1966*b*), in accordance with the quality and quantity of autumn cropping cannot be acceptably explained through a gene concept denying the inheritance of acquired properties. Thus, the category of mutation is not applicable to autumnization. The homogeneity of the initial stock renders doubtful, in the first place, the explanations built up on original heterogeneity, such as the validity of WADDINGTON's canalization concept.

The homogeneity of the initial stock of the autumnization-genetical experiments proved to be the main target of my numerous partners in debates while lecturing in Europe and North America in the sixties, just as it happened on the occasion of my presenting the Academic Doctor's dissertation in Budapest on the 30th November, 1966. Recently some critics have attached special hopes to the monosomic analysis of the autumnization plant material (RILEY, in: RAJKI 1966*b*).

In the meantime I was able to obtain the Cambridge F_1 data on the monosomic analysis of the Martonvásár autumnization plant material. These investigations are performed on 3 variants of the third autumnization cycle (S = initial spring, SW = going to be autumnized, W = autumnized). The fixing of the program for mutual Cambridge — Martonvásár investigations was concluded at Martonvásár in 1965, and not much later, investigations started at Cambridge with seed-samples obtained from Martonvásár; after the return of my wife and co-worker E. RAJKI from her 5 month study-trip in Cambridge, investigations started at Martonvásár as well.

In the course of monosomic analysis at the autumnization of Lutescens 62, raising F_2 would be — beside F_1 — also of great interest. On the basis of the Cambridge F_1 data it can already be established that from the monosomic analysis of the autumnization there can be drawn general conclusions — which essentially agree with the results of the investigations that have been carried on at Martonvásár for 12 years with other genetical as well as physiological and biochemical methods — as follows:

a) the initial stock of the autumnization-genetical investigations is homogeneous;

b) in the course of autumnizing spring wheat, not only the habit of the plant but, under the influence of the environment, the chromosomes, the "genes" have also changed.

2) For ten years vernalization-biochemical investigations have been carried on at Martonvásár (DÉVAY 1962, 1965*a*, 1965*b*, 1965*c*, 1966, 1967*a*, 1967*b*) on the evidence of which my co-worker M. DÉVAY has presented her Academic Doctor's dissertation in these days. It is hoped that next year this dissertation, too, will be published in English.

On the strength of these examinations — and especially from the reactions of nucleic acid and protein synthesis inhibitors — it can be established that during vernalization we have to reckon with parallel reactions which, under the effect of low temperature, will, after all, result together in the flowering induction. These processes can be classified in two wide groups:

a) The biochemical reactions occurring in the shoot-tip, as a result of which the latter becomes — under the long-day photoperiodic induction — to initiate flower-primordia. To these reactions belong the activation and synthesis, respectively of isoenzymes being active at low temperature (amylase, transaminase, RNase, ascorbin oxidase), of specific RNA and nucleoproteids as well as the synthesis of isoenzymes with high temperature optimum and specific DNA in the course of vernalization and at its end, respectively.

b) The synthesis of the recipient (or probably the transferring) system of the long-day photoperiodical induction or the stopping of the synthesis inhibition in the foliage leaves. Here is primarily to be mentioned the appearance of the thermolabile and thermostabile forms of the phytochrome in the second part of vernalization.

DÉVAY, in her dissertation (1967*c*) has made an attempt at drafting the "biochemical mechanism" of the vernalization of winter wheat.

The autumnization-genetical and the vernalization-biochemical investigations are being carried on in close co-operation on the basis of the same concept. The biochemical processes considered characteristic of vernalization are worth while to be investigated in the autumnization-genetical experiments. At the same time, in the spring initial stock developing de novo these biochemical processes, their "phylogenesis" can be well checked by the biochemical examination of autumnization. Both types of investigations — together with other basic investigations at Martonvásár (RAJKI 1960; RAJKI—PÁL 1966) have contributed to the drawing up of the metabolic-biochemical concept of heredity and will contribute to its developing.

In the biochemistry of vernalization and in the genetics of autumnization we have only been interested theoretically so far. Recently a breeding program has been started at Martonvásár in which autumnization populations are to be the basic material for selection.

REFERENCES

CHARGAFF, E. (1963): Essays on Nucleic Acids. Amsterdam, London, New York. 212.

DÉVAY, M. (1962): Biochemical Processes in Vernalization. In: Symposium on Wheat Genetics and Breeding, Martonvásár. 17—40.

DÉVAY, M. (1965*a*): The Biochemical Processes of Vernalization. III. The Changes of Ascorbic Acid Oxidizing Capacity in the Course of Vernalization. Acta Agr. Acad. Sci. Hung., **14**, 93—97.

DÉVAY, M. (1965*b*): The Biochemistry of Vernalization. IV. The Changes of Ribonuclease Activity in the Course of Vernalization. Acta Agr. Acad. Sci. Hung., **14**, 275—287.

DÉVAY, M. (1965*c*): A fény minőségének hatása a tavaszi és őszi búzák anyagcseréjére, különös tekintettel a hőmérsékletre és a fotoszintetikus aktivitásra (The Effect of the Quality of the Light on the Metabolism of Spring and Winter Wheats). Bot. Közl., **52**, 215—219.

DÉVAY, M. (1966): The Biochemical Processes of Vernalization. V. The Formation and Localization of Ribonuclease I. Acta Agr. Acad. Sci. Hung., **15**, 85—94.

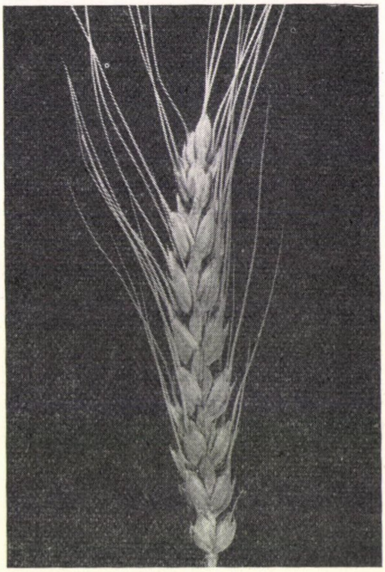
DÉVAY, M. (1967*a*): The Effect of Various Antimetabolites in the Course of Vernalization. Acta Agr. Acad. Sci. Hung., **16**, 251—252.

DÉVAY, M. (1967*b*): The Biochemical Processes of Vernalization. VI. The Change of the Phytochrome Content in the Course of Vernalization. Acta Agr. Acad. Sci. Hung., **16**, 289—295.
DÉVAY, M. (1967*c*): Az őszi búza jarovizációjának néhány élettani problémája (Some Physiological Problems of the Vernalization of Winter Wheat). Akadémiai doktori disszertáció, Budapest.
RAJKI, E. (1960): Tojásgyümölcs (*S. melongena* L.) vegetatív hibridek (Vegetative Hybrids of the Egg-plant [*Solanum melongena* L.]). Növénytermelés, **9**, 205—230.
RAJKI E.—PÁL, GY. (1966): Transplantation ofa Part of the Berry Fruit of *Solanum melongena* L. Acta Agr. Acad. Sci. Hung., **15**, 301—309.
RAJKI, S. (1962): Data on the Genetics of Converting Spring Wheat into Winter Wheat. In: Symposium on Wheat Genetics and Breeding, Martonvásár. 63—98.
RAJKI, S. (1963): The Conversion Process by Autumnization of Wheat. Hereditas. Suppl., **2**, 469—471, 476—477.
RAJKI, S. (1965): Conversion of Spring Wheat into Winter Wheat and its Genetic Interpretation. Acta Agr. Acad. Sci. Hung., **13**, 263—285.
RAJKI, S. (1966*a*): Environmental Influence and Selection. Acta Agriculturae Scandinavica, Suppl., **16**, 248—252.
RAJKI, S. (1966*b*): The Role of Environment and Selection in Autumnization of Wheat. Savremena poljoprivreda, **14**, 553—564.
RAJKI, S. (1966*c*): On the Situation in Genetics, Martonvásár. 48; also in Hungarian and Russian.
RAJKI, S. (1967): Autumnization and its Genetic Interpretation, Budapest. 88.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 245—280 (1968)

VARIA

KOMPOLTI 169 ŐSZI BÚZA
(Winter Wheat Kompolti 169)



Systematical place: Triticum aestivum L. var. *erythrospermum* (Körn.) Msf.
Origin: Produced, by individual selection, from winter wheat *F. 481.*
Beginning of breeding: 1949, Kompolt.
Breeder: János Lelley, Plant Breeding Station of the South-Lowland (Alföld) Research Institute, Kiszombor.
State qualification: Preliminary certified improved variety, 1957 (Kapás *et al.* 1965).
General characterization: Early maturing, winterhardy, drought-resistant, high-yielding winter wheat of extensive character, having red grains, the quality of flour being medium (Papp 1963).
Morphological description:

Root system: The well-developed roots reach into the soil as deep as 100—110 cm.

Shoot system: From the tillering node being deep in the soil, several branch-shoots (tillers) get developed. The result of productive tillering is an average of 450 ears per m^2 (ranging from 355 to 501 ears; Papp 1956—1963).

Culm: 107 cm on the average (range: 85—125 according to years), thin, elastic, with medium liability to lodging. Degree of lodging evaluated 2.9—3.6 (best = 5), (Papp 1956—1963). On the culm there are generally 4, sometimes 5 nodes. The internode bearing the ear, is greyish, somewhat glaucous (Lelley 1967).

Foliage: The leaf of the young plant is narrow, light green, drooping (sometimes even to the ground) and the auricle is reddish-lilac. The number of developed foliage leaves is 4—5, the blades are narrow, lineallanceolate and of light yellowish-green colour. The posture of the flagleaf is straggly.

Ear: awned; when young, it is light green, when ripe, whitish-yellow; 6—9 cm long, fusiform, being of a rather loose structure and drooping. The average number of flowers in the spikelets is 3, however, triple pollination is rare so that the average number of grain per ear is 17.8 (deviation: 12.5—20.6). Average grain-weight in the ear is 0.623 g (deviation: 0.474—0.783). The lamella of the awnless glumes is narrow, sloping shouldered (rounded off), the apex being cuspidated. At the time of ripening it is not liable to the scattering of grains.

Caryopsis: of elongated elliptical form. Size: medium, the apex is rounded off, awny (brush), the germ scutum is round, in the middle of which a well-developed embryo is visible; its radicle-part protrudes somewhat below the grain. Grain is reddish. The substance of the endosperm is mealy or partly glazy. Average weight of thousand grains is 35.6 g (deviation: 28.6—38.0 g). The weight of one hectolitre is 75—80 kg. Dry gluten proportion is 10—22 per cent. The baking quality of its flour is medium; flour-quality is B_4—B_2.

Biological characters:

Germination: The cardinal points of germinating are: minimum +2 °C, optimum 10 °C, maximum 35 °C. The duration of germination in the optimum is 5.6 days (Mándy 1961).

Vegetation period: from seeding to earing on the average 219 days (ranging from 206 to 225 days), from seeding to ripeness on the average 263.2 days (ranging from 249 to 271 days) (Papp 1956—1963).

Development: quick, vigorous; in autumn and spring its tillering is very intense; shooting, earing and maturing occur earlier than with the starting form, the *F. 481.*

Winter hardiness: Good performance. The dying out in winter amounts to no more than 2.5—2.7 per cent (Mesch 1964) (winter-killing).

Resistance to diseases: Because of its early maturing, it escapes infestations of stem-rust (black rust); it is, however, susceptible to leaf-(brown) rust and mildew; as to powder-smut, it is but slightly susceptible (Papp 1963).

Farm technology requirements:

Sowing in Hungary is advantageous during the period October 1—20. Seed-requirement per cad. yoke (1 cad. yoke = 1.422 acres = 5754.56 m²) 3—3.1 millions of embryos (520—640 embryos/m²).

Soil: There are no high requirements as to the state of cultivation and to that of being supplied with nutriment (Kapás *et al.* 1965). When given too much nitrogen fertilizer, it gets lodged, while the rations of the chemical fertilizer "pétisó" amounting to 1—2 q, are very well utilized (Lelley 1967). Unfavourable conditions are of no importance, therefore that wheat variety is rather indifferent to soil: even on poor soil, after a preceding green crop having exhausted the soil or the crop being harvested late, the wheat in question will produce fairly good yield. Droughts and extensive conditions are tolerated well (Lelley 1967).

Productivity: According to several years' average, the yield is at an average 16.15 q/cad. yoke (ranging from 11.4 to 19.1 q/cad. yoke). The ratio of grain-culm is 33 : 67 (Papp 1963).

Area of cultivation: On the northern, high-land soils with poorer cultivation, and even on the Great Hungarian Plain, on poorer wheat-soils, the growing of that variety is satisfactory (PAPP 1963).

GY. MÁNDY

REFERENCES

KAPÁS, S. *et al.* (1965): Minősített növényfajtáink (Qualified Hungarian Plant Varieties) Mezőgazdasági Kiadó, Budapest.

LELLEY, J. (1967): A fajtakérdés és a magyar búzafajták (The Problem of Varieties and the Hungarian Wheat Varieties). Mezőgazdasági Kiadó, Budapest.

MÁNDY, GY. (1961): A csírázáshőmérséklet kardinális pontjainak vizsgálata hazai őszi búza fajtákkal (Examination of the Cardinal Points of Germination Temperature in Hungarian Winter Wheat Varieties). Buzatermesztési Kisérletek 1952—1959. Akadémiai Kiadó, Budapest. 10—109.

MESCH, J. (1964): Búza fajtagyűjteményes vizsgálatok eredményei. I. Termés és termést kialakító tényezők alakulása 1960-ban és 1961-ben (Results of Varietal Collection Examinations in Wheat. I. Developments of Yield and Factors of Yield Formation in 1960 and 1961). Agrobotanika, **5**, 63—116.

PAPP, ZS. (1956—1963): Őszi búza (Winter Wheat). Nemesített Növényfajtákkal Végzett Orsz. Fajtakisérletek Eredményei (Results of National Variety Trials Conducted with Improved Plant Varieties). Mezőgazdasági Kiadó, Budapest.

PAPP, ZS. (1963): Fontosabb hazai és külföldi búzafajták (Important Hungarian and Foreign Wheat Varieties). In: LELLEY, J.—MÁNDY, GY. (1963): A búza (Wheat), *Triticum aestivum* L., Akadémiai Kiadó, Budapest. 277.

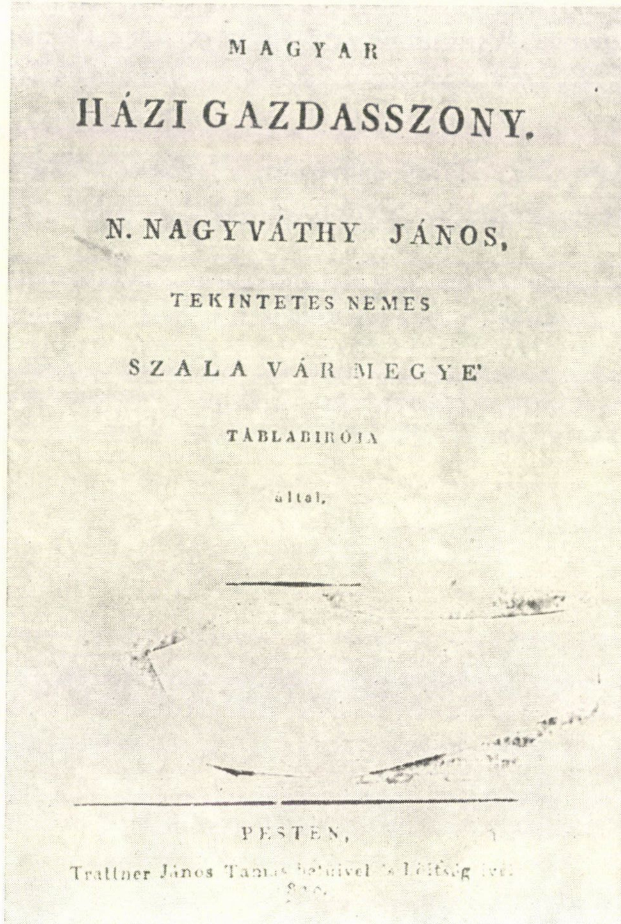
THE FIRST HUNGARIAN COMPREHENSIVE DATA ON HOUSEWIFE ACTIVITIES

"... and the black earth bears wheat and barley, and the trees are laden with fruit, and the sheep bring forth and fail not, and the sea gives store of fish, and all out of his good guidance, and the people prosper under him."

(Homer: Odyssey, Book XIX)

These lines of Homer come into our mind when turning over the pages of the history of the Hungarian people and when studying the role of our women in it. The comparison is not in the least accidental. Returning home from the siege of Troy after several years' adventurous wanderings, Odysseus finds a well-managed homestead being a credit to the activities of Penelope, the immortal woman-character of world literature. Neither does Hungarian history lack war activities; now the Turks, then the Germans forced the men folk to join battle while the directing of farming was taken over by the women. The keen way our women had hold their ground, is well pictured by a letter written in the 16th century by an aristocratic lady, Kata BÁNFFY, to her husband Count Ferenc BATTHYÁNY who was away in war: "We had much work to do because from all the region of Muraköz we had been ordered to fortify the entrenchments of the town. The tieing up of the vines had been also completed. Enough cabbage had been planted. It was only our Lord who had saved me from not being captured by the Turks, — about which fact you may learn from other people, too."

(Körmendi ltr. Missiles., quot.: TAKÁTS)



MAGYAR

HÁZI GAZDASSZONY.

N. NAGYVÁTHY JÁNOS,

TEKINTETES NEMES

SZALA VÁR MEGYE'

TÁBLABIRÓJA

által.

PESTEN,

Trattner János Tamás betűivel 's költségével.

Fig. 1. The front-page of NAGYVÁTHY's book

These letters offer rich sources on the life in old Hungarian castles and mansions as well as on the farming and housewifely occupation of their women. What did that activity consist of? First of all, the directing of the household, the "family" (the young folks, servants, craftsmen, etc.), the upbringing and educating of the young were the main tasks of the lady of the house. All this was required by the patriarchal character of life in ancient Hungarian country-seats. In larger country-homes a "family" consisting of more than 70—80 members, had to be provided for. Besides woman's activities taken in the strict sense of the word (as spinning, sewing, lacemaking, etc.), the vegetable garden, poultry-raising, the fattening of pigs, vintage, the desiccating of fruit, the growing and collecting of medicinal herbs, also belonged to the housewifely duty. It was gardening that they used to do with special pleasure and with good results, as proved by the letters. Countess T. NÁDASDY sent early cabbages in May of the year 1549 to Katalin FRANGEPAN who, in her reply, writes as follows: "Isto tempore capita caulium in isto regno nos vidisse nunquam" (Never have seen cabbage here in this time of the year). (NÁDASDY correspondence, National Archives, quot.: TAKÁTS). Since the aristocratic ladies have been treaters or, rather, doctors not only of their own courts but of almost the whole region, — great attention has been paid to the growing of drug plants, too. Tangible objects of the above are all the instruments and distilling equipments used for preparing concoctions and perfumes, we come across in the inventory-book of almost every old country-seat.

On the far-reaching and manifold housewifely activities János NAGYVÁTHY is the first to submit a literary summary in his book: Magyar Házi Gazdasszony ("The Hungarian Housewife") published in 1820. (Pest, János Tamás TRATTNER.) The topics of the book prove that, at the end of the 18th century, women's work ranged over similar fields as those that had been noted in the letters of previous centuries. Though it is to be mentioned that in the days of NAGYVÁTHY it was rather the smaller mansions of the nobility and the peasants' farms whose women took such share in directing household-farming while in the 16th—17th centuries even the consorts of the reigning princes in Transylvania did not shrink from such tasks (cf. Bethlen Miklós Önéletírása — Autobiography of Count Miklós BETHLEN). From the middle of the 18th century on, the majority of the Hungarian higher nobility lived abroad and their ladies, too, gave up their household at home. There were but few ladies, setting good example also in patriotic feelings, — like the wife of Count György FESTETICS, — whose experiences in household-management NAGYVÁTHY also availed himself of in his book (cf. the letter of Countess FESTETICS to the step-daughter of NAGYVÁTHY; quot.: Kálmán NAGYVÁTHY).

Before reviewing, however, the above-mentioned book, let us say a few words about the author. In the personality of János NAGYVÁTHY our literature on agrarian history appreciates the man who "rendered Hungarian agriculture to become a real science" (cf. Vilmos LÁZÁR: Nagyváthy János emlékezete — The Memory of J. NAGYVÁTHY). He was born from an impoverished noble family in Miskolc in the year 1775. After finishing his studies in law and theology at the Sárospatak school, he became tutor in an aristocratic family and later, he continued his educating activities in Losonc. On the occasion of one of his visits to Pozsony, his interest was aroused in agriculture and, therefore, he went to Pest in order to study agronomy at the university. Here he was deeply impressed by the lectures of Prof. MITTERPACHER. As a soldier he visited Austria, Italy and even Belgium, and in Vienna he got into touch with the free-masonry ideas. Through this movement he became acquainted with two of his aristocratic patrons, Count Ferenc SZÉCHÉNYI and Count György FESTETICS. After the theoretical start obtained from Prof. MITTERPACHER and his observations gained during his travellings abroad, he first managed to apply, in practice, his agricultural knowledge on the Vöslau estate (near Vienna) where he was working for a while in the capacity of a volunteer agriculturist.

His first publications were political pamphlets (a fashionable literary genre of those days) in which, besides enlightened idealism, there is also a gleam of some mental forerunners of reform-age democratism. In the year 1791 was published his work: A szorgalmatos mezei gazda ("The Assiduous Farmer") that, due to its comprehensive character and being written in Hungarian, is an epoch-making work in our agricultural literature.

This work consisting of two volumes the publication of which was supported by Count Ferenc SZÉCHÉNYI, comprises the main branches of agriculture. The book called the attention of Count Gy. FESTETICS, too, and as a result he asked the author to accept the position of manager on his Keszthely estate of 162 000 cad. yokes. NAGYVÁTHY reorganizes the estate with great consciousness, applying new methods. He realizes and makes the Count realize, too, that to have good experts, is an important condition of managing an estate. It was on his advice that, in 1797, Count FESTETICS started the Georgicon for the training of new-type farm managers.

The most productive period of NAGYVÁTHY's activities as an agrarian writer are the days spent in Csurgó. Here, on a 40 cad. yoke estate given him by the Count, he established a miniature model farm. On his experiences he reported in the "Tudományos Gyűjtemény" (Scientific Collection) or, personally, at the meetings of the Georgicon and the Helicon. A rich material of manuscripts has been left behind of which the "Practicus Termesztő" (The Practical Farmer), the "Practicus Tenyésztő" (The Practical Breeder), the "Magyar Gazdatiszt" (The Hungarian Farm Manager), the "Magyar Házi Gazdasszony" (The Hungarian Housewife) were published shortly after his death (February 24, 1819). Kálmán NAGYVÁTHY (NAGYVÁTHY's nephew) mentions some other works, too: "A Magyar Haza Gazdálkodása Smith és Soden Után Kidolgozva" (Farming in Hungary after Smith and Soden), the "A Magyar Földes és Zászlós Úr" (The Hungarian Landlord and Banneret), "Ismerettár" (Encyclopedia) (the latter being only half-way ready), two volumes of poems (!) — these, however, got later lost. Magyar Házi Gazdaasszony — "The Hungarian Housewife" appeared first in the series of the posthumous works. From the introductory words of the book the high standard aims of the author can be detected:

. . . "What this Book contains has been tried several times by quite a number of countrywomen as well as in my own house, and are mostly experiences of Hungarian ladies. In the books of Hungarian Writers dealing with that subject, neither the whole of the problem nor a close choice of it, and even less than that: Domestic Practices could be found." (Preface)

NAGYVÁTHY's book is divided into two main parts: "A Gazdasszonyságról közönségesen" (About Housekeeping in General) and "A Házi Gazdasszony munkáiról" (On the Works of the Housewife).

In the first part he enumerates one by one, the most important tasks of the housewife in each month of the year. That calendar-like "memento" shows that, in agricultural work, NAGYVÁTHY attaches great importance to the proper organization of work, to the full utilization of time and to the proportional distribution of the yearly tasks. The calendar is especially helpful in gardening — an activity in which the co-operation of weather and working performance is very important. This is followed by intentions of instructive character. What does NAGYVÁTHY expect from the good housewife? First of all, that she should direct the domestic works "with peaceful patience, good example, through teaching and all this in a kind manner, however, maintaining her dignity". To her merits belong skill, thriftiness, cleanliness and diligence. Author expresses his principles in maxim-like sentences, as e.g.: "If the housewife does not know her duties, she cannot be successful in management"; "The housewife is the foremost person in the house"; but: "Even the most clever housewife should discuss matters with the master of the house". NAGYVÁTHY also tells us what is to be considered when choosing and instructing maid-servants. As to the problem how to treat them, he stresses the necessity of goodwill and delicacy. The first part of the book gets finished with the description of the inner rules of the house; as main principle, he points out the respecting of the strict order of the day as well as the accurate farm-accounting. As early as at the time of reorganizing the FESTESICS-estate in Keszthely, NAGYVÁTHY introduces the double-entry book-keeping the application of which was a first venture of that kind in this country. However, receipts and expenses, furniture and allowances in kind had to be registered not only by the master, the farm-manager but also by the housewife.

From practical point of view the second part of the book containing a description of different housewife works, is more important and useful. Actually it is a treasury of NAGYVÁTHY's experiences and working methods observed and collected by himself. But before summing up them, we must know that even around the turn of the 18th–19th centuries landlords' farmsteads, the mansions of nobility and peasants farms were equally compelled to live on their own production. Therefore, the main activity of the housewife was to secure the requirements of the household (food, clothing, hygiene, etc.). Among others, NAGYVÁTHY first deals with bread-making as the most important and, perhaps, the most beautiful housewife work. This priority in the sequence somewhat demonstrates the fact that bread is a highly appreciated food for the Hungarians; according to the author the good quality of bread depends on many factors as: on choosing the wheat, milling, leaven, kneading, forming the dough into loaves etc. In his opinion "... that bread is always the better the two halves of which is wheat and one half is rye" (Magyar Házi Gazdasszony — The Hungarian Housewife, p. 81). Its flavoury taste, durability and nice form depend on the leaven. To make the dough raise, in those days leavened dough scraped and gathered off the sides of hutch, was used and that being kneaded together with bran on which boiling hot-water had been poured previously and that mass was broken to pieces, — or, instead, some quantity of thin dough was kept for the purpose. The former was preferred in the region of the river Tisza and was called (in Hungarian) "pár" or raiser* while the latter was known (in Hungarian) as "záporka" in theTransdanubian district. A leavening material is the hops known from its being used in breweries. "In our country ... it used to grow abundantly in woods, copses and around the hedges of vineyards and gardens (cf. Magyar Házi Gazdasszony — The Hungarian Housewife, p. 84). Just for fun and for oddity, let us follow — in brief — the labour-process of bread-baking according to NAGYVÁTHY's description! That work requires much time. The housekeeper sops the raiser in warm water as early as the previous night, she bolts or sifts the flour one third of which she mixes with warm water and with the raiser, and the leaven thus produced is being kept warm for 6—8 hours. The hutch is covered by pillows. The work continues at 2—3 o'clock a.m.; when the top of leaven settles and gets burst, the housewife mixes and stirs it with salty hot-water and two thirds of the flour and then starts kneading; that is going on for about an hour. The aim is to get the leavened dough thoroughly mixed with the flour which, according to NAGYVÁTHY, has to be performed in the following way: "the person doing the kneading thrusts one of her fists after the other into the dough without stopping, however, getting the hand off always with spread fingers". Two hours after kneading there follows the forming of loaves; the dough "raises and gets crackled here and there, and the middle of it begins to settle". When forming loaves, the dough is kneaded again being turned from one side to the other and once the loaves have taken up their round shape, "they are put into bread baskets lined with the cloth that had previously been dredged with flour". After allowing raising for another half-hour, loaves are put into the oven the previous heating of which also requires much skill. Thus, we might retrace, on the basis of NAGYVÁTHY's description, the beautiful ancient working-process going more and more into oblivion even in the villages of this country.

The second interesting part of NAGYVÁTHY's book is the description of the special phases of flax- and hemp processing like e.g.: the harvesting of flax and hemp, retting, cutting, scutching, dressing, reeling, spinning, weaving which, nowadays, are known by our women only on ethnically more closed territories of our country. As in several parts of his books, here, too, the author avails himself of the experiences of his travellings abroad. In connection with bleaching he refers to the so-called "Dutch method" that he ... "used to see more than once in Austria in the workshops of Schwechat and Himmberg" (p. 109). Special chapters are devoted to starch- and soap-making, the candle-moulding and dipping, the preparing of vinegar all of which had to be produced by the housewife since light-industry was not yet developed in those days. In these chapters, however, we come across not only the description of the method of production and technical instructions but also meet with observations calling the attention to utilizing local facilities:

"In certain regions of our country there exist woods for public use, among them at Jánosháza in the county Vas, where there grow several kinds of wild fruit. Not to make use of this treasure of Nature, would be unwise. Therefore, it is only laudable that country-folk gather wild apple and pear, which, after being crushed and squeezed, are sieved into jars, thus producing vinegar" (p. 143).

Or, for instance, speaking of the Debrecen-soap, he suggests that on the alkali flats of the Great Hungarian Plain, on the Kis-Kunság (a district of Central Hungary), in the counties

* In the Bácska region it is still nown by this name.

Csongrád, Békés, Bihar, Szabolcs there can be found plenty of sodium carbonate needed for making soap. These seemingly unimportant observations prove that NAGYVÁTHY knew very well the economic features of different parts in this country, and — in his writings — he kept in mind these feasibilities.

To housewife's tasks belonged also the keeping of livestock for supplying the household with food. In the book a special subject consists of the treatment of milking cows, the rearing of calves, pig-fattening and the breeding of poultry. As to rearing calves, he considers the most important to maintain the purity of bred. It is not good, for instance, to wean the calf too early, because, as he says: "by doing so, even the best Swiss cows get retrograded".

Author deals, in details, with the processing of milk, the producing of butter and cheese. It is the only field among the housewife's activities where commercial measures are also involved besides the covering of domestic demands. Author calls the attention to that possibility especially in villages being near the bigger towns. This chapter of NAGYVÁTHY's book is taken over and quoted from another work of his (A Practicus Tenyésztő — The Practical Breeder). On the processing of milk an interesting historical résumé on the basis of ancient authors, is submitted. From this we learn, for instance, that it was HERODOTOS who first mentioned that "... the Scythians had produced butter from mare's milk". Later data are found concerning the above, in the works of HIPPOKRATES, the poet ANAXANDRIDES, ARISTOTELES, and PLINIUS MAIOR. After this short résumé the author excuses his "scholastical priggishness" and, as a matter of fact, we do not come across again such deviating off his subject. Most probably, the cause of it is not the lack of knowledge since his previous references, too, show that during the years spent in Keszthely, he must have frequently been in Count Gy. FESTETICS's famous library where he had the opportunity to find rich agricultural literature. The reason seems rather to be that NAGYVÁTHY has built up all his activities as agrarian writer, on practice. He writes in the preface of the Magyar Gazdatiszt (Hungarian Farm Manager): "Everything that has been seen by me in practice, is collected here." These personal experiences and observations are summarized in that work.

In connection with pig-rearing and the breeding of poultry, he also writes about the most frequent diseases, about how to prevent and cure them.

That NAGYVÁTHY has always been watching the results gained in his age, is well illustrated by the following observations, — though this prophecy of his has not come true: "The Egyptian way of chicken hatching in warm ovens applied also in France, will never be successful in this country: the cold weather prevailing here, will kill the chicks when there's no brood-hen with them. I have tried it myself" (Magyar Házi Gazdasszony — The Hungarian Housewife, p. 223).

In the last chapters of the book NAGYVÁTHY deals with the growing of vegetables and flowers. The garden vegetables are grouped according to the part of the plant utilized (leaf, root, flower, etc.). First, he expounds general information and requirements on the growing of vegetables, then he describes what kind of soil is required by each plant; the right time of sowing, the spacing of seedlings; the exact time suited for hoeing, hilling up and irrigation. He lays stress on the importance of good seed. Garden flowers are classified according to the way of propagation. The method with which he produces new shades in carnation, is described remarkably not only from professional point of view, — these are almost poetical descriptions (he even wrote two poems!) "... the pollen being at the bottom of the flower, on the ends of the tube, has to be taken off with a very narrow and smooth little knife between 9 and 10 o'clock in the morning. This should be put on the white and round arms* of the most beautiful two maidens. The pollen thus becoming impregnated, the most fertile seeds will be produced. In this way, with the pollen of different flowers, especially the white carnation can be turned

* Here: arms = pistils

yellow, multicoloured, ashen-grey, black, etc." (Magyar Házi Gazdasszony — The Hungarian Housewife, p. 276). That description, rare in agrarian literature, is to express a symbolic picture of the process now called hybridization. Comparing NAGYVÁTHY's book with the Hungarian translation of a German book of similar character (VERES Mihály: A jó gazdasszony, Pozsony és Pest 1796, — The Good Housewife), we can impartially point out that "The Hungarian Housewife" is a more professional and better utilizable work being also more systematically designed in its structure. Before writing A Szorgalmatos Mezei Gazda (The Assiduous Farmer), NAGYVÁTHY had meditated on the problem whether it might be better to translate a work of some noted foreign writer. His book: Magyar Házi Gazdasszony (The Hungarian Housewife) shows his being fully conscious of the necessity of learning, that it is not necessary — and not even advisable — to imitate them in everything but rather to rely on our experiences. And the very demand for being original (a trend prevailing at the end of the 18th century, one of the first supporters of which was NAGYVÁTHY) that has promoted the unfolding of our agrarian literature and, of course, these original works have exerted an influence also on the development of our agriculture.

M. CSERNÁK

REFERENCES

LÁZÁR, V. (1955): Nagyváthy János emlékezete (A Commemoration of J. Nagyváthy). MTA Agrártudományi Osztályának Közleményei, *VII*, 3—4.

MAKKAI, L. (1957): Paraszti és majorsági termelés a XVII. sz.-ban (Economy of the Peasantry and Seignioral Domestic Economy in the 17th Century). Budapest.

NAGYVÁTHY, J. (1820): Magyar házi gazdasszony (The Hungarian Housewife). Pest, Trattner János.

NAGYVÁTHY, K. (1891): Nagyváthy János élete (The Life of J. Nagyváthy). Pozsony.

RADVÁNSZKY, B. (1879—1896): Magyar családélet és háztartás a XVI—XVII. sz.-ban (Family Life and Housekeeping in Hungary in the 16th—17th Centuries). Budapest.

RAPAICS, R. (1940): Magyar kertek (Hungarian Gardens). Királyi Magyar Természettudományi Társulat, Budapest.

TAKÁTS, S. (1914): Magyar nagyasszonyok (Noble Ladies in Hungary). Élet, Budapest.

TRÓCSÁNYI, Z. (1937): Kirándulás a magyar múltba (Retrospective Glance at the Hungarian Past). Kir. Magyar Egyetemi Nyomda, Budapest.

ELECTRON MICROSCOPIC EXAMINATION OF THE MITOTIC SPINDLE

Our knowledge on mitotic cell division has increased considerably through light- and electron microscopic examinations (BAJER 1966, HARRIS–MAZIA 1962, DE HARVEN–BERNHARD 1956, MAZIA 1960). In spite of this, several phases in the process of cell division have not been elucidated up to now, and it often occurs that there are contradictions in the experimental results obtained by different methods and in the conclusions, respectively. Among these unsolved problems the most discussed one is the mechanism of the moving of chromosomes towards the cell-poles. According to light-microscopic examinations (BAJER 1966) in fixed preparations there can be observed the so-called "spindle fibrils" adhering to the surface of chromosomes and, in the anaphase, they "stretch" the chromosomes to the poles. Since in living cells neither the light- nor the phase-contrast microscopic examinations have proved the presence of spindle fibrils, the theory of their role in the orientated moving of the chromosomes has been disregarded by many a scientist. Polarization microscopic studies (BAJER 1966)

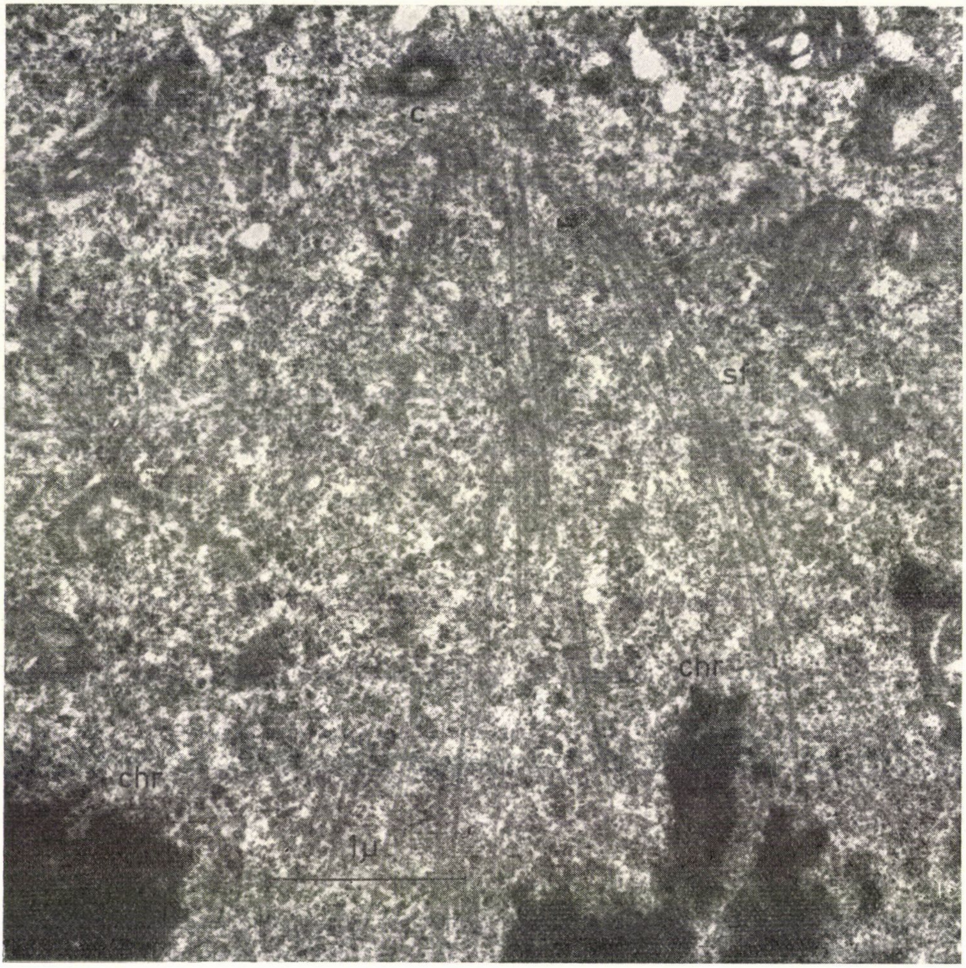


Fig. 1. Németh—Kellner lymphoma cell in the phase of mitotic division. The centriole (C) is visible on the pole of the cell while the chromosomes (chr) are found in the equatorial (plane). Several spindle-filaments (sf) run from the chromosomes towards the centriole. ×26 000

and electron microscopic examinations (HARRIS–MAZIA 1962, GEORGE *et al.* 1965, LAPIS 1967, ROBBINS–GONATAS 1964) have proved, without any doubt, the presence of the so-called "spindle filaments" or stretch-filaments, however, that statement has not yet granted a satisfactory explanation. The spindle-filaments are built up of protein being 130–270 Å thick particles; as to their function, it might be presumed that, by contraction, the chromosomes are pulled towards the poles. That view was disregarded recently because the contracted fibres ought to get thickened which, however, could not be proved so far. Our examinations did not aim at deciding the questions discussed, we only wanted:

1. to obtain data on the existence of the spindle-filaments when applying various ways of fixation,

2. to study the morphological contact between the spindle-filaments and the chromosomes,

3. and finally, we have studied, in connection with the effect of spindle poisons (Vincaleukoblastin), the troubles in the formation of the mitotic spindle, — at ultra structural level.

In our examinations the rapidly proliferating Németh–Kellner lymphoma cells were used as test-objects. For the preservation of the stretch-filaments the 2 per cent solution of OsO_4 prepared according to Palade (1951) and the 2.5 per cent glutaraldehyde prepared with the isotonic Hanks solution as used by George *et al.* (1965), were applied. As spindle-poison 1 mg/kg of Vinca-leukoblastin was injected into the peritoneal cavity of Swiss white mice; previously the above-mentioned tumour-cells had been transplanted into it.

In agreement with most literary data, in the dividing tumour cells according to Palade, no mitotic spindle stretch-filaments could be evinced. In the isotonic Hanks solution, when performing 2.5 per cent glutaraldehyde prefixing, in the mitotic cells well-preserved centriole and stretch-filaments focussing from the chromosomes to the centrioles, could be demonstrated (Fig. 1). Kinetochores could not be observed on the chromosomes; this, however, might be due to the fact that the components in question did not fall within the section. In the Figure it can be observed that the spindle-filaments might equally adhere to the poles and to the central part of the chromosomes. On the peripheric part of the cytoplasm mitochondria take place. Our second Figure also demonstrates the apical pole of a tumour cell. This time the centriole did not fall within the zone of the section, however, the spindle-filaments branching ray-like towards the chromosomes, can be well discerned. On the end of one of the chromosomes it can be well observed that the spindle-filament joins directly the dense part of the chromosome without the intercessing of the kinetochore. In our pictures more enlarged (Figs 3 and 4) the diameter of spindle filaments can be well measured, which, in the case of our examined objects, is 150—250 Å on the average. The length of the filaments might be several microns. In some cases filaments bind the contrasting heavy metals (lead, uranium) very strongly (Fig. 3), therefore, the structure of filaments is highly granulous. In other cases, however, the whole filament is stained homogeneously and its fine structure is less granulous (Fig. 4).

In the 6th hour following the Vinca-leukoblastin treatment, amorphous, chromosome masses sticking together are visible in the cytoplasm of the mitotic tumour cells (Fig. 5). In several places, on the area of the chromosomes clinging closely together, well-developed kinetochores can be observed. Spindle-filaments or their fractions could not be perceived either on the surface of chromosomes or on the peripheral part of the cytoplasm. The mitochondria visible between the chromosomes indicate a disturbed mitotic process.

On the basis of our experimental results, the following conclusions can be established:

a) In cells fixed according to Palade, spindle-filaments cannot be demonstrated. Most probably, this is due to the fact that the slowly diffusing hypotonic osmium tetroxide causes the destruction of spindle-filaments.

b) The glutaraldehyde fixation in isotonic Hanks solution preserved well the spindle-filaments and renders them ultrastructurally evinceable.

c) The size and the structural peculiarities of the filaments identified by us, are in good agreement with literary data. Since the diameter (150—250 Å) of spindle-filaments falls into the range of electron microscopic resolution, it may be taken for granted that the light-microscopically visible spindle-filaments are not separate staple filaments but represent the adhering bundle of them.

d) A difference can be shown in the contrast of filaments even in the case of identical staining process. That fact indicates that the chemical nature of filaments (e.g. their stainability) might change in the function of the mitotic process.

e) In the case of the examined objects, spindle-filaments might equally got linked to the polar and central part of the chromosomes even without the interaction of the kinetochores.

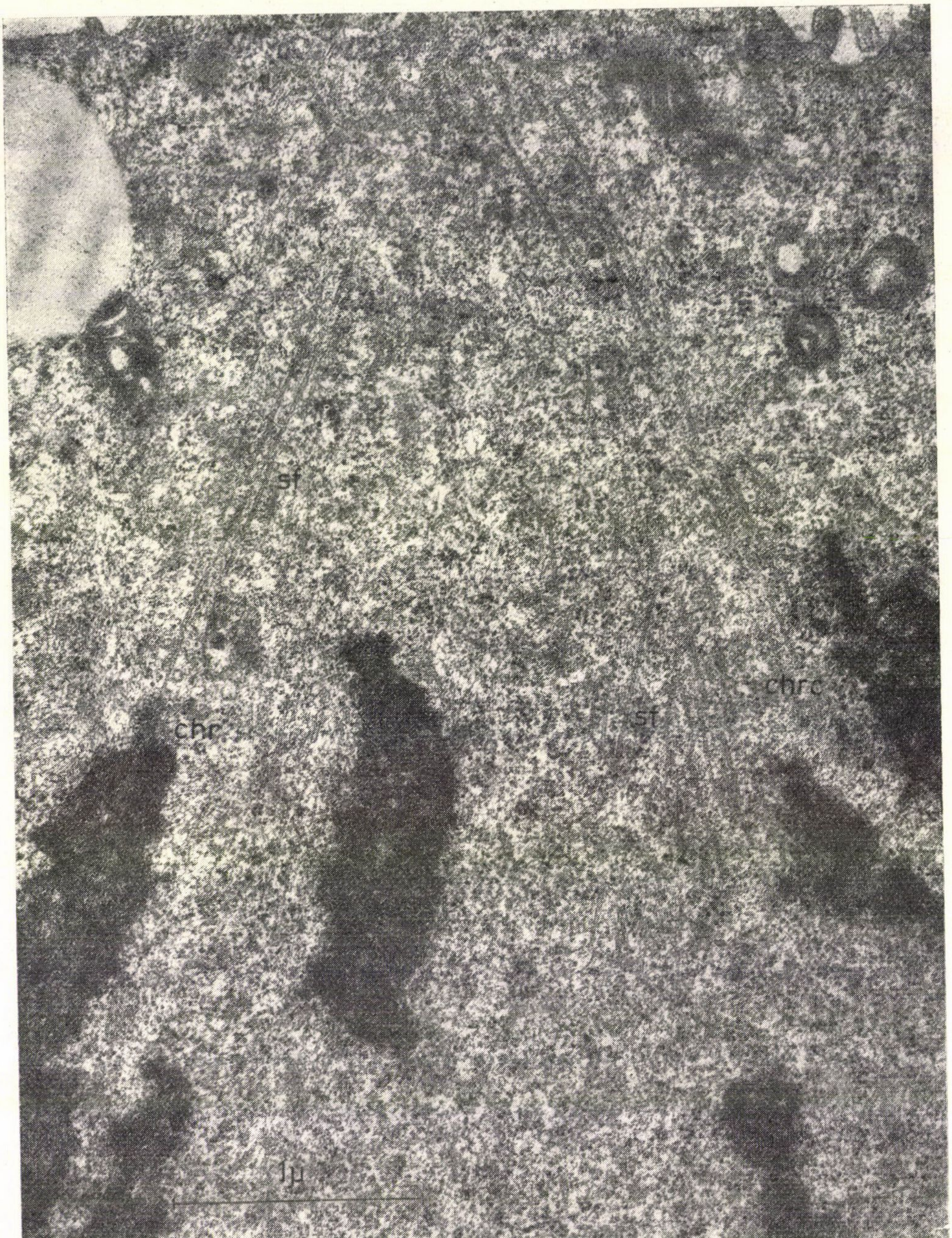


Fig. 2. Spindle-filaments (sf) often join the polar part of chromosomes (chr), however, there are many cases in which filaments can be seen adhering to the central part of chromosomes (chr). ×33 000

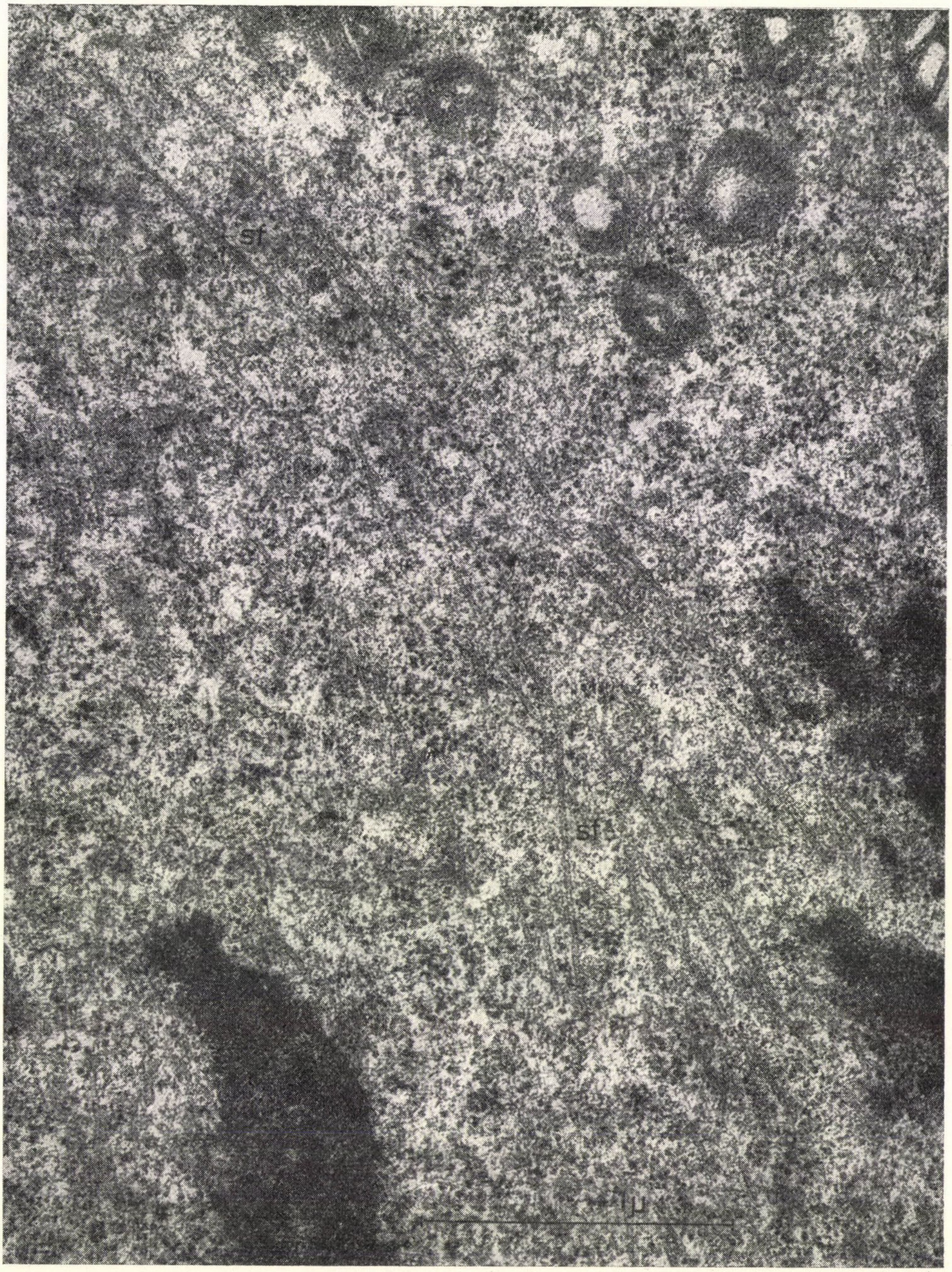


Fig. 3. With greater magnifying it becomes visible that the spindle-filaments (sf) correspond to tubelets having a diameter of 150—250 Å and being some microns long. The borders of the tubuli bound the contrasting material very strongly and, therefore, their structure is finely granular. ×42 000

Fig. 4. Sometimes the spindle-filaments (sf) are less contrastizable, their inner part is filled with medium electron dense material. On one of the chromosomes (chr_1) as much as two adhering spindle-filaments can be observed. $\times$48 500

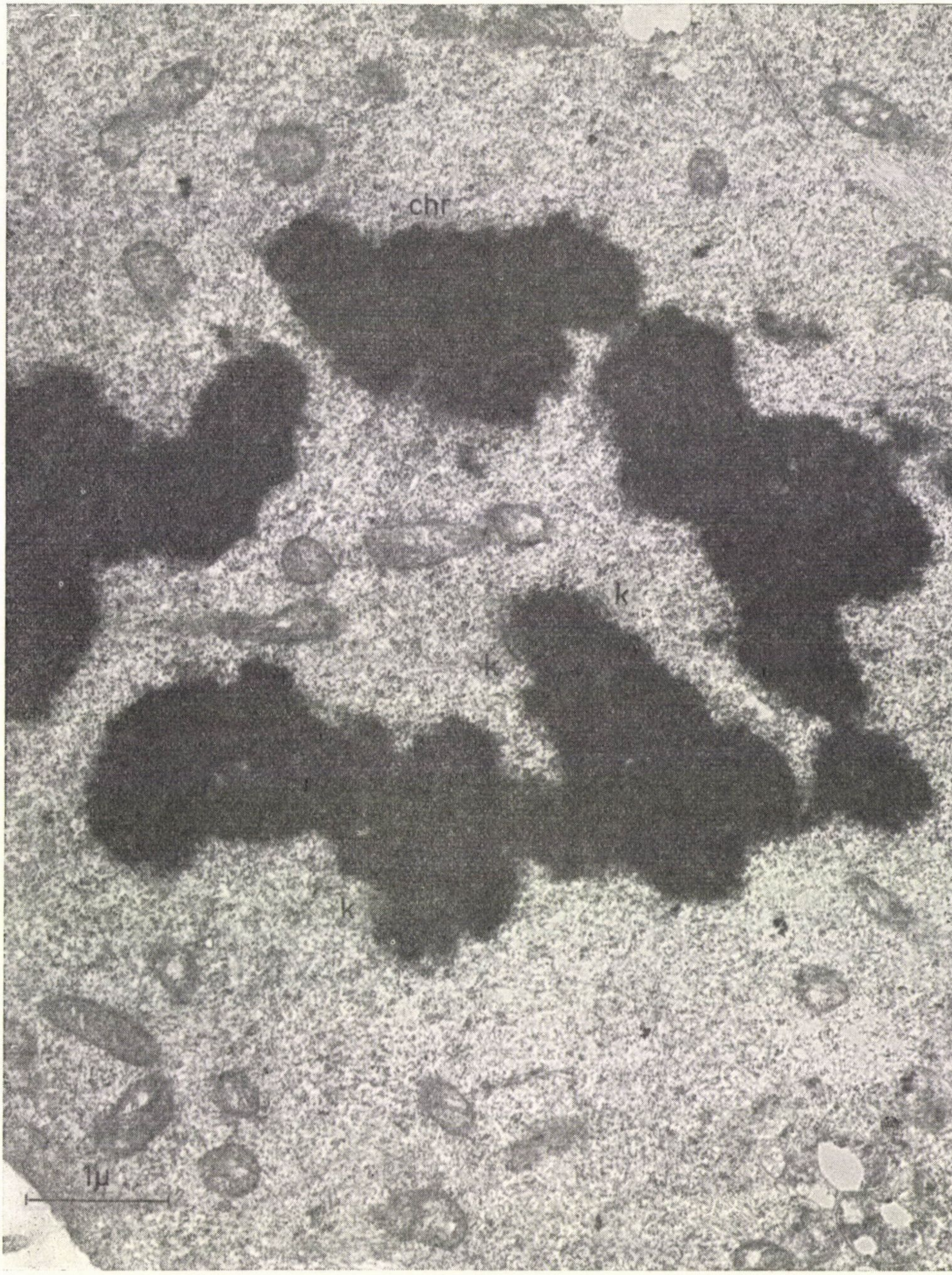


Fig. 5. 6 hours after Vinca-leukoblastin treatment in the dividing tumour cells highly electron dense chromosomes (chr) can be seen twisted and knotted up in ring-form. The occurrence of spindle-filaments could be observed neither in the chromosome zone nor in any other area of the cytoplasm. On the other hand, well-developed kinetochores (k) can be seen on several chromosomes. $\times 19\ 000$

f) The Vinca-leukoblastin treatment blocks the mitotic process of the tumour cells in the metaphase. Presumably, the "metaphase-stop" is brought about by the fact that the synthesis of spindle-filaments is disturbed. That hypothesis is based on the examination of CREASEY and MARKIW (1964) in which they have demonstrated that spindle-poisons inhibit the synthesis of soluble RNA. On this basis the above authors suppose that as a result of the inhibited RNA-synthesis the synthesis of the specific proteins necessary to produce spindle-filaments, is also being inhibited. However, in connection with other data (MAZIA 1960, MAZIA 1961, MAZIA–ROSLANSKY 1956) it has been established that the mitotic apparatus is built up of synthesized proteins before mitosis proteins. According to GEORGE *et al.* (1965) the cells being already under division, can finish their mitosis in spite of Actinomycin-D treatment, though it is known that Actinomycin-D highly inhibits the synthesis of soluble RNA. On the basis of these observations, an opinion has recently prevailed according to which spindle-poisons are — also directly — able to alter the filamentary formation (stretch-filaments) of the mitotic apparatus without inhibiting the accomplishment of specific substances necessary for the synthesis.

*

Prepared by the Postgraduate Medical School, Department of Pathology, Budapest

I. BENEDECZKY, K. LAPIS

REFERENCES

BAJER, A. (1966): Morphological Aspects of Normal and Abnormal Mitosis. In: Probleme der biologischen Republikation. Ed. P. Sitte. Heidelberg. 90—117.

CREASEY, W. A.—MARKIW, M. E. (1964): Biochemical Effects of the Vinca alkaloids I. Effects of Vinblastine on Nucleic Acid Synthesis in Mouse Tumor Cells. Biochemical Pharmacology, **13,** 135—142.

DEHARVEN, E.—BARNHARD, W. (1956): Etude en microscope électronique de l'ultrastructure du centriole chez les Vertébrés. Z. Zellforsch., **45,** 378—398.

GEORGE, PH.—JOURNEY, L. J.—GOLDSTEIN, M. N. (1965): Effect of Vinchristine on the Fine Structure of HeLa Cells during Mitosis. J. Nat. Cancer Inst., **35,** 355—375.

HARRIS, P.—MAZIA, D. (1962): The Finer Structure of the Mitotic Apparatus. In: The Interpretation of Ultrastructure. Harris, R. J. C. A. P. New York—London 279—305.

LAPIS, K. (1967): Vinca leukoblastin hatására ascites daganatsejtek finomszerkezetében létrejött elváltozások (Changes Brought about in the Fine Structure of Ascites Tumour Cells by the Effect of Vinca leukoblastin). Acta Morph. Acad. Sci. Hung. (in press).

MAZIA, D. (1960): The Analysis of Cell Reproduction. Ann. N. Y. Acad. Sci., **90,** 455—469.

MAZIA, D. (1961): Meiosis and Mitosis: Mitosis and the Physiology of Cell Division. In: The cell. Biochem. Physiol. Morph., **3,** 77—412.

MAZIA, D.—ROSLANSKY, J. D. (1956): The Quantitative Relations between Total Cell Proteins and the Proteins of the Mitotic Apparatus. Protoplasma, **46,** 528—534.

PALADE, G. E. (1951): A Study of Fixation for Electron Microscopy. J. Exp. Med., **95,** 285—298.

ROBBINS, E.—GONATAS, N. K. (1964): The Ultrastructure of a Mammalian Cell during the Mitotic Cycle. J. Cell. Biol. **21,** 429—463

ROBBINS, E.—GONATAS, N. K. (1964): Histochemical and Ultrastructural Studies on HeLa Cell Cultures Exposed to Spindle Inhibitors with Special Reference to the Interphase Cell. J. Histochem. Cytochem., **12,** 704—711.

SEPARATION OF PROTEINS IN BARLEY LEAVES

The MFB (Martonvásár) barley plants have been raised under conditions at 9000 lux intensity (Lasztity—Horváth 1965). Roots were removed on the 7th day. The isolated leaves were placed in a solution of kinetin 2.2 mg/1 l, benzyladenine 2 mg/1 l, benzylidazol 60 mg/1000 ml tap-water. The detached leaves being kept in tapwater and the plants with roots were applied as controls. Every day a few mms were cut from the leaves of plants without root and

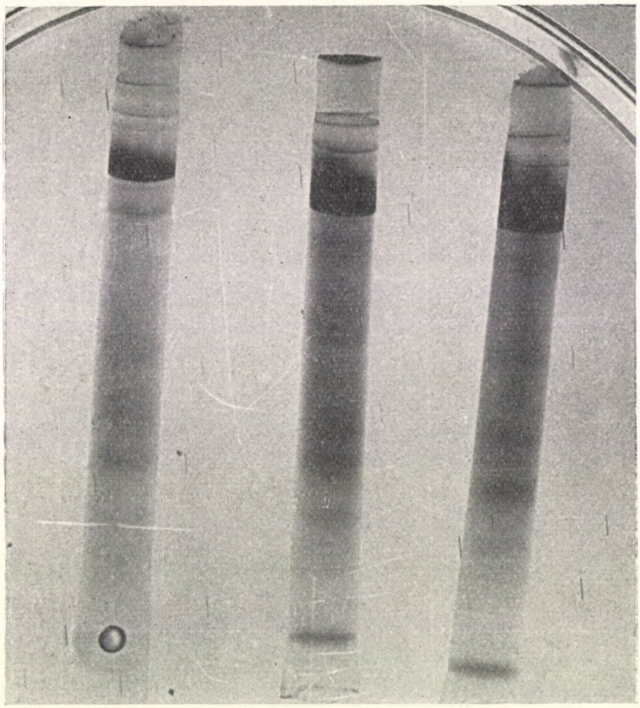


Fig. 1. Protein fractions of barley leaves kept, during isolation, for 5 days in tap-water (1st column); in kinetin solution (2nd column) and those of intact plants as visible on gels

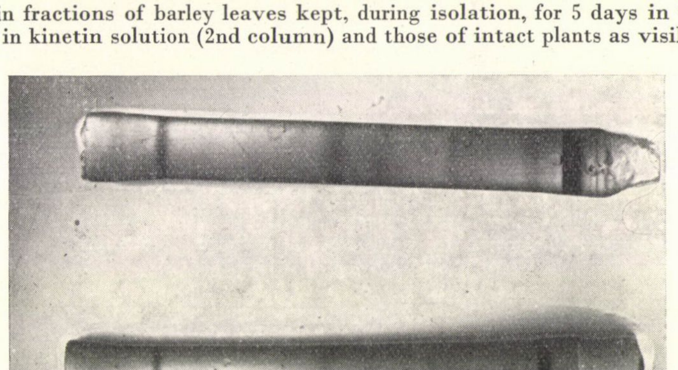


Fig. 2. Protein fractions of barley leaves kept for 5 days in tap-water after isolation, in parallel

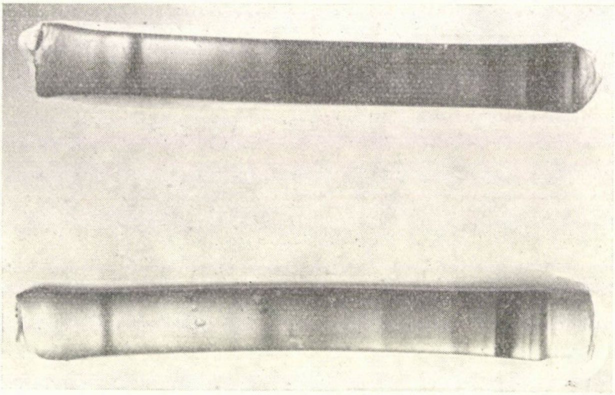


Fig. 3. The parallels of those kept in kinetin solution

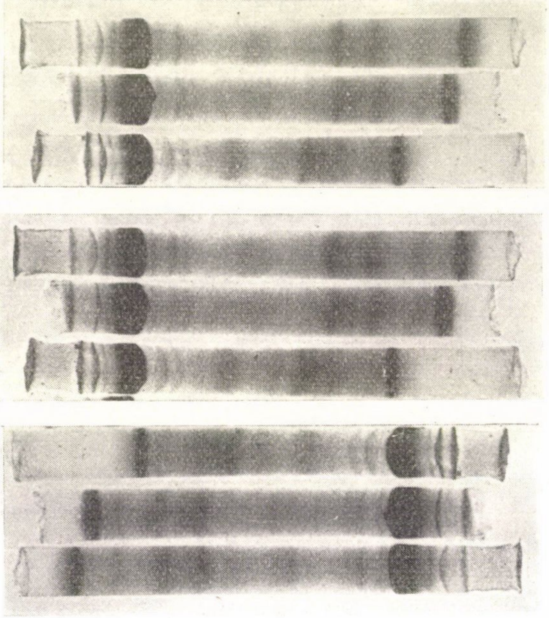


Fig. 4. The parallels of those kept in benzyladenine solution

the solutions were changed. Examinations were performed after isolations of 5 to 7 days The number of repetitions was 8—15.

Extraction and separation of proteins. Proteins were extracted in 0.1 M tris (hydroxymethyl) aminomethane (Tris) buffer (pH 8.0) containing 0.1 per cent ascorbic acid, and 0.1 per cent cystein hydrochloride. Extracts were centrifuged for 60 min in the Spinco model analytical ultracentrifuge at 100 000 g. Polyacrylamide gel (disc) was carried out as described by DAWIS in 1964. The gels were stained for total proteins with 1 per cent aniline blue black in 7 per cent acetic acid. The gels, after staining were washed in 7 per cent acetic acid. Patterns obtained were photographed after 3 days (FARKAS — STAHMANN 1966).

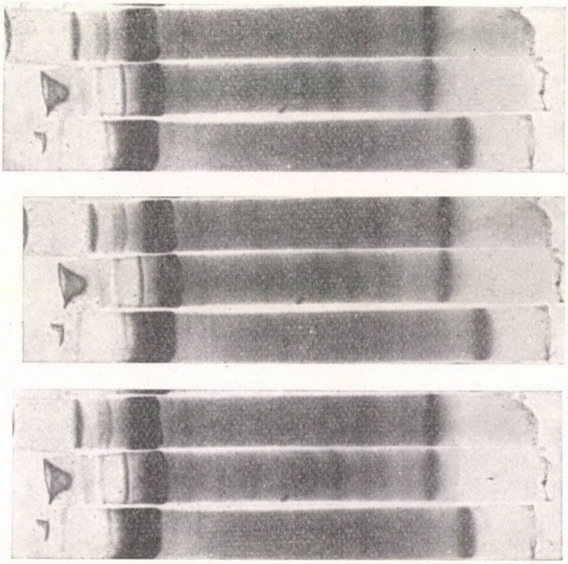


Fig. 5. The parallels of those kept in benzimidazole solution

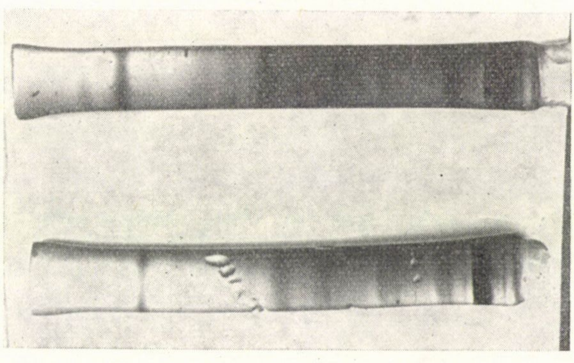


Fig. 6. The parallels of the intact plants

In Figures 1—7 it can be seen that about 15—20 fractions are obtainable on the gel. It has been examined whether kinetin and compounds of similar effect retain those separable fractions that are characteristic of the plants having roots. On the basis of the rather qualitative evaluation, the following can be established. In case of the leaves of intact plants 16—18 fractions could generally be separated. After removing the roots, the quantity of these decreased to 13.11 and even below 10 in the leaves being kept in tap-water. The effect of benzyladenine, benzimidazole and kinetin might be more pronounced with intact plants.

*

Prepared by the Department of Plant Physiology and Geology of the L. Eötvös University, Budapest.

M. Horváth, L. Klinda

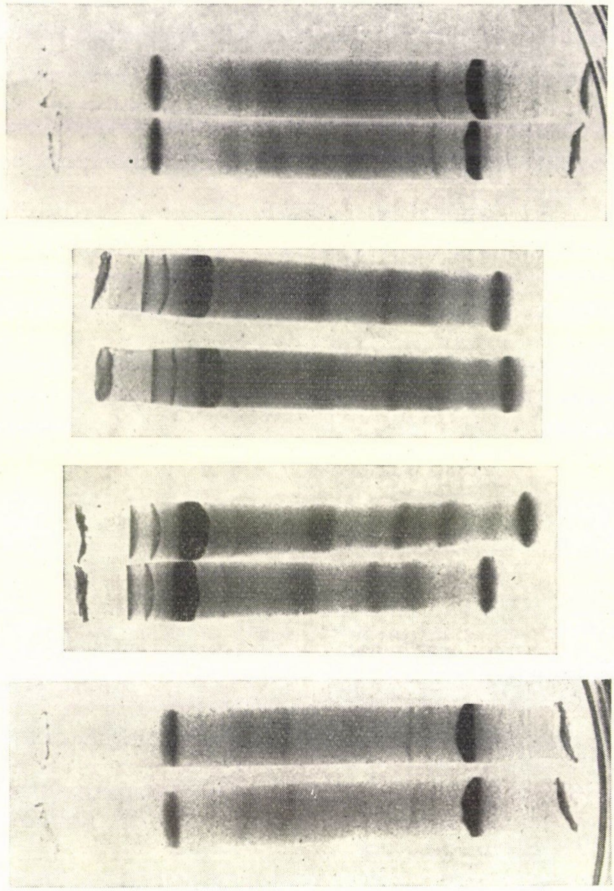


Fig. 7. Protein fractions of the leaves being isolated for 7 days and of the intact control on the gel-columns; 1. in water, 2. in kinetin solution, 3. in benzyladenine solution, 4. the control with root

REFERENCES

DAWIS, B. J. (1964): Disc Electrophoresis. II. Method and Application to Human Serum Proteins. New York Acad. Sci. Ann., **121**, 404—427.

FARKAS, G. L.—STAHMANN, M. A. (1966): On the Nature of Changes in Peroxidase Isoenzymes in Bean Leaves Infected by Southern Bean Mosaic Virus. Phytopathology, **56**, 669—677.

LASZTITY, D.—HORVÁTH, M. (1965): Changes of Pigments in Barley Leaves. Acta Agr. Acad. Sci. Hung., **14**, 321—326.

FORMATION OF THE SIZE OF PETAL AND LEAF IN SOME OF OUR OIL FLAX VARIETIES UNDER THE INFLUENCE OF DIFFERENT WEATHER- AND FERTILIZING CONDITIONS

To important taxonomic characters of cultivated flax (*Linum usitatissimum* L.) belong the dehiscence of the capsule or that it remains closed; the size of seed, capsule and flower; the colour of seeds, corolla and anther; the height of the plant; besides the hairiness of the capsule's pseudo-septum, the form and size of the leaf (MÁNDY 1955), as well as the size and forming of the petal (MÁNDY 1951, SEDLMAYR—BAKSAY 1955).

According to SHAW (1931) precipitation, temperature and soil might exert influence on the shades of colour in the flower. The problem had to be elucidated whether the size of leaf and petal would change under the influence of oecological effects.

In 1966 oecology and fertilization experiments were performed in Tápiószele with five important oil flax varieties bred and grown in this country *(Szerepi, Szegedi Alfa, Maros, Olajözön* and *Szegedi 7222).*

On the plots randomly arranged and of four repetitions, increasing quantities (25, 50, 100, 200, 400, 800 kg/cad. yoke) of the fertilizer "Péti só" (active agent about 22% N) were applied. Sowing was performed at three dates: 1966 March 29; April 12; April 26. Thus, in the experiment there were 18 treatments.

In the emergency-flowering phenophase the following periodical values of weather prevailed (MÁNDY 1967):

Sowing period	Phenophase	Temperature sum °C	Mean temperature °C	Precipitation mm
I.	III. 29—V. 29	926.7	14.9	67.4
II.	IV. 12—VI. 9	944.4	16.5	46.9
III.	IV. 26—VI. 23	1031.7	18.8	55.4

Test-material was gathered in, corresponding to sowing dates, in every fortnight, at the end of the flowering (V. 26, VI. 23). In the morning hours, 1 petal each and medially situated leaves were, per repetition, plucked from 5 plants each; thus, in each treatment 20 samples each were available.

According to MÁNDY's (1955) morphological categories, the foliage-leaf of all the five varieties is medium long (2.5–4 cm) having narrow lamella (below 5 mm). The leaves are lanciform, no difference exists that would be characteristic of the variety. The petal of the Szerepi oil flax is always smaller: about 7—9 mm wide and 12—14 mm long. Those of the other varieties do not show considerable differences. Their width is 11—13 mm, while their length is 14—19 mm.

These characteristic sizes are maintained even when treated with different doses of the fertilizer "Péti só" as well as under different weather conditions. And yet, in the three sowing dates a difference appears in the size of petal and foliage-leaf, too. On the other hand, the fertilizer doses do not cause considerable difference. In all treatments, similarly to the untreated plants, the length and width of the petal showed the maximum in each of the flax varieties sown at the second sowing date.

An interesting, however reverse change may be seen in the size of the medium-situated foliage-leaf. Here, too, in each treatment — similarly to that of the untreated — the length and width of the foliage-leaf showed minimum in varieties sown at the second sowing date.

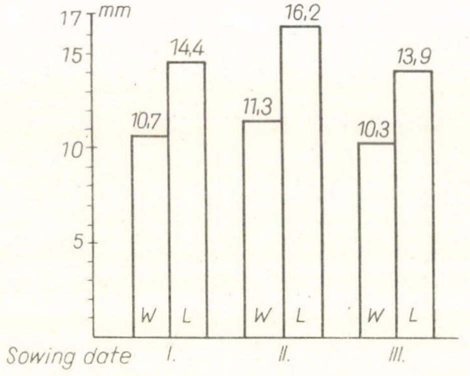


Fig. 1. Width (W) and length (L) of petals in oil flax not treated with fertilizer, — at three sowing dates (mean of variety)

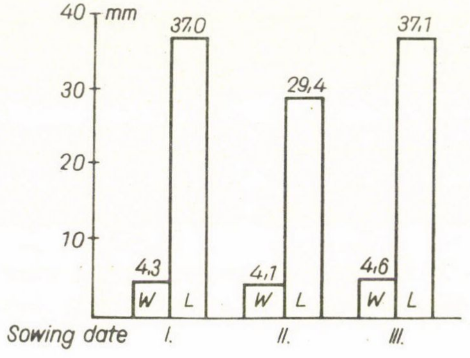


Fig. 2. Width (W) and length (L) of the medially situated foliage-leaf in the oil flax varieties not being fertilized, — at three sowing dates (mean of variety)

In Figures 1 and 2 the width and length of petals and those of medium-situated leaves in the untreated oil flax varieties are shown at three sowing dates on an average of the varieties.

From the weather data it can be seen (see the above compilation) that the least quantity of precipitation is that corresponding with the second sowing date. Most probably, this is the cause of the decrease in the size of the foliage-leaf and of the increase of the petal, respectively. Thus, it can be established that, though weather conditions do somewhat modify the size of petals and foliage-leaves, they do not exert influence on the general proportion and form these being important when determining the variety.

*

Prepared by the National Institute of Agrobotany, Tápiószele.

L. Szabó

REFERENCES

MÁNDY, GY. (1951): A len — *Linum usitatissimum* L., (The Flax). In Soó, R.—Jávorka, S.: A magyar növényvilág kézikönyve I (The Handbook of the Hungarian Flora I). Akadémiai Kiadó, Budapest. 457—461.

MÁNDY, GY. (1955): Újabb alaktani nézőpontok a lenfajták meghatározásához (New Morphological Viewpoints to Determine Flax Varieties). Növénytermelés, 4, 25—32.

MÁNDY, GY. (1967): Olajlenek fenoökológiai vizsgálata (Pheno-oecological Examination of Oil Flaxes). Akadémiai doktori értekezés (Thesis). Országos Agrobotanikai Intézet (National Institute of Agrobotany), Tápiószele.

SEDLMAYR, K.—BAKSAY, L. (1955): A len (The Flax). Magyarország kultúrflórája (Cultivated Plants in Hungary). Akadémiai Kiadó, Budapest.

CULTIVATED PLANTS AND THE HEAT SUM

Agricultural meteorology, plant ecology and plant production often refer to the "heat sum" of cultivated plants or that of periods of agricultural technology. According to the determination of BERÉNYI (1951) "heat sum" is the expression of the "heat requirement" of the various plants and is "nothing else than the summing up of means for the daily temperatures during a certain period". BERÉNYI remarks that "this accepted term is accurate because not the sum of the heat amounts but the sum of temperatures is in question". Thus according to this author the correct denomination is "temperature sum" yet literature generally uses the term "heat sum". Being given the fact that in literature two conceptions of summing up are found in connection with the daily mean values of temperatures: 1. all days' mean values of the period are added and 2. only mean values above a certain threshold value (e.g. 5° C) in a period are summarized; the first term could be named temperature sum while the second heat sum. From this it follows that the temperature sum is a meteorological, while the heat sum a biological concept.

There is no doubt that the determination of the threshold value of temperature is rather arbitrary and often even inexact, thus, heat sums calculated from this threshold are burdened with more or less error. The threshold value could be a real limit of measure only if the relative data were known for each variety and if we knew the cardinal points of development; the determination of these, however, is very circumstantial, it may often even change and therefore only superficial data can be found. We commit a much lesser error if we simply reckon with the sums of temperature.

As regards the temperature sums, opinions are rather varying in literature. Some authors accept while others reject their use. The condemnations are in most cases due to the fact that more information is expected from the temperature sums than this value can ever supply. A characteristic example for this attitude is the remark of SIPOS (1964) who considers the "heat sum method" imperfect for the reason that "the daily mean temperature does not tell us which way the temperature has developed during the day".

Still more objections are taken in this respect by YAKUSHKIN (1950) who condensates his comments in five points:

"1. On various geographical points and under various climates the sum of heat degrees is differently increasing according to progress toward the west;

2. on the same point in various years the fluctuations of the amounts referred to are substantial;

3. in these calculations the useless summer surplus temperatures and the effectless spring temperatures were included;

4. the relationship of the various crops to morning frosts and overheating is not expressed;

Table 1

Temperature (°C) sums of cereals in sowing time variations

Winter wheat				Rye		Winter	
1960/61		1961/62		1962/63		1962/63	
Seeding date	°C	Seeding date	°C	Seeding date	°C	Seeding date	°C
26. IX.	2515.2	3. XI.	1802.6	19. IX.	1994.2	19. IX.	1738.3
11. X.	2300.2	10. XI.	1720.6	26. IX.	1934.2	3. X.	*1491.7**
25. X.	2210.8	16. XI.	1690.8	3. X.	1777.0	17. X.	1319.0
5. XI.	2108.0	27. XI.	1672.5	10. X.	1682.3	31. X.	1343.9
21. XI.	2127.0	4. XII.	1634.1	17. X.	1634.5		
5. XII.	2005.5	12. XII.	1607.6	24. X.	1607.0		
				31. X.	1533.6		
				7. XI.	1480.8		
				14. XI.	1418.7		
Literature: 2000 °C (1), 2100 2200 °C (2)				1800 °C (2) 2200 °C (1)		1700–2200 °C (2)	

5. the sum of the temperature requires substantial changes depending on the conditions of illumination."

It is evident that Yakushkin demands such informations from the temperature sum that cannot be established out of the daily mean temperatures either. In fact, the temperature sum is only a relative index of the heat sum that became effective during the vegetation period, the value of which — naturally — changes according to the geographical locality, the conditions of production, the year and the variety. It is obvious that it includes also the "useless" and the "effectless" temperature values.

It should be conceived in no way that the temperature sum is some sort of constant value even if in some papers on cultivation the repetition of old data might arise such appearance. This is due in most cases to the fact that there are few pertaining data in literature and even the existing ones are not the means of many years but often rough estimates.

A comprehensive characterization of the temperature during the vegetation period is — however — necessary, from more than one viewpoint. According to Berényi (1951) "the mean temperature . . . gives practically little information" on this, although "from the point of view of cultivation we have to know the heat amount which is available in the majority of years". Sipos (1964) emphasizes that "the heat sums of the vegetation period decisively influence the crop yield and at the same time determine the plants that can be cultivated". When geographically planning the cultivation the "many years' probability values of the vegetation period" can be readily used (Berényi 1951). Thus all results of research are important which enlarge our knowledge in connection with the heat sum of the cultivated plants.

In the course of ecological research concerning our cultivated plants the present author paid special attention to the study of the heat sum of cereals. In the ecological row developed with the delayed sowing technique we systematically reviewed the phenological phenomena of the most important varieties. The phenological data made it possible to calculate the vege-

as observed in Tápiószele and as found in literature

barley				Spring barley		Oat	
1963/64		1964/65		1963		1963	
Seeding date	°C	Seeding date	°C	Seeding date	°C	Seeding date	°C
23. IX.	1508.1	17. IX.	2151.7	3. IV.	1267.9	3. IV.	1655.9
7. X.	*1371.2**	24. IX.	2034.5	17. IV.	1312.6	17. IV.	1619.0
21. X.	1235.3	30. IX.	1967.3	30. IV.	1224.5	30. IV.	1532.0
4. XI.	1096.4	8. X.	1947.7	15. V.	1251.7	15. V.	1486.2
		15. X.	*1842.4**			29. V.	1673.9
		22. X.	1896.0				
		29. X.	1879.1				
		6. XI.	1857.6				
		13. XI.	1853.8				
		20. XI.	1805.1				
Mean of *optima**: 1568.4 °C							
Literature: 1700—2200 °C (2)				1700—2500 °C (2)		2100—2730 °C (2)	

(1) Berényi 1951, (2) Hajas—Rázsó 1963

tation time and its several developmental periods as well as the connected temperature sums. Thus we obtained data on the development of the different varieties under various meteorological influences and the necessary heat sum. It appeared that the temperature sums obtained for the most part differed from the data found in literature (Tables 1 and 2). The differences are once very considerable (summer barley, oat, maize, hop), then much less, in other cases most important again. In the ecological row (proceeding from early seedings toward later ones) the temperature values gradually diminish but there are cases when in the latest seedings (oat, flax) slight increases of value were experienced and there was even a series observable when the distribution was suggestive of the optimum curve (summer barley). Since in the ecological sense the seeding periods may become effective also as the effect of years, the temperature sums obtained in the experiments inform also on the measure of fluctuation.

Summarizing the above observations it can be established that in spite of some condemnatory opinions in the literature the temperature sums supply much valuable information to the practice particularly from the viewpoint of the planning of cultivation and the zoning scheme of varieties. Thus it is an important task to determine the temperature sums with ecological experiments. From our own examination conducted on these lines we obtained in the overwhelming majority of cases values different from those published in literature. This is mainly due to the fact that the data of literature do not originate from experiments conducted in Hungary but from foreign sources.

*

Prepared by the National Institute of Agricultural Botany, Tápiószele.

Gy. Mándy

Table 2

Temperature (°C) sums of cereals and industrial crops in sowing time variations as observed in Tápiószele and as found in literature

Maize					
1959		1961		1962	
Seeding date	°C	Seeding date	°C	Seeding date	°C
20. IV.	2623.4	29. III.	2865	26. IV.	2400.8
4. V.	*2511.6**	12. IV.	2752	10. V.	2216.4
1. VI.	2104.7	26. IV.	*2535**	24. V.	*2232.8**
		10. V.	2534		
		24. V.	2482		
		7. VI.	2365		

Mean of *optima**: 2390.4 °C

Literature: 2800 °C (Hajas—Rázsó 1963)

Flax		Hop	
1965		1959	
Seeding date	°C	Cutting date	°C
23. III.	1899.5	19. III.	2695.0
6. IV.	1790.3	2. IV.	*2539.3*
20. IV.	1760.5	16. IV.	2366.5
4. V.	1686.8	30. IV.	2213.3
18. V.	1707.4		

Literature: 3000 °C (Hajas—Rázsó 1963)

REFERENCES

Berényi, D. (1951): Magyarország éghajlata (The Climate of Hungary). In Aujeszky L.—Berényi, D.—Béll B.: Mezőgazdasági meteorológia (Agricultural Meteorology). Akadémiai Kiadó. Budapest. 237—271.

Hajas, J.—Rázsó, I. (1963): Mezőgazdaság számokban (Agriculture in Figures). Mezőgazdasági Kiadó. Budapest.

Yakushkin, I. V. (1950): Növénytermelés (Plant Production) Vol. I. Mezőgazdasági Kiadó. Budapest. 33

Sipos, G. (1964): Földmíveléstan (Agronomy). Mezőgazdasági Kiadó. Budapest. 22—23.

EFFECT OF FERTILIZERS ON THE QUALITY OF WHEAT

The effect of fertilizers, when used as top-dressing, has been studied on the material of 5 fertilizer-experiments set by KOLTAY throughout 3 years (1964, 1965, 1966).

The soil of the experimental plot was rich in humus, being of fields-clay character with a very varying thickness of the upper layer. The layout of the experiments was 6×6 Latin squares; the size of one plot being 28.7 m². The dosages of fertilizers were applied in the middle of March each year. The varieties examined were *Fertődi 293* and *Bezostaya 1*. Concerning *Fertődi 293*, the material of 3 years' experiments while with *Bezostaya 1*, that of 2 years' experiments were examined.

The experiments were made with the following treatments:

1) Untreated control
2) Nitrogen (N) (139 kg/ha)
3) Phosphorus (P) (139 kg/ha)
4) Nitrogen + phosphorus (NP) (139 + 139 kg/ha)
5) Nitrogen + phosphorus + potassium (NPPK) (139 + 139 + 139 kg/ha)
6) 1/2 NPPK

The effect of fertilizer-treatments exerted on quality has been demonstrated by the "complex qualitative index" (POLLHAMER 1967)—introduced by us and comprising 10 partial factors (crude protein per cent, wet gluten per cent, Zeleny's number, gas retaining capacity in the minute, the Farinogram index, bread volume cm³, water absorbing capacity per cent, ratio of bread form, the expansiveness of gluten mm, and the hull-content per cent.

On the basis of our experimental data the following could be established.

The quality of *Fertődi 293* is considerably poorer than that of *Bezostaya 1* (Table 1).

From the data of the Table it can be seen that the various fertilizers changed the complex qualitative indices in a different way with each variety. The NPPK treatment had a highly improving effect on both varieties, although in the case of *Fertődi 293* the NP treatment produced the same effect.

Table 1

Complex qualitative indices of the wheat varieties Fertődi 293 and Bezostaya 1

Martonvásár, 1964, 1965, 1966

Treatment	Complex qualitative index	
	3 years' average of *Fertődi 293*	2 years' average *Bezostaya 1*
1. Untreated control	92.6	156.0
2. Nitrogen (139 kg/ha)	106.0	135.0
3. Phosphorus (139 kg/ha)	91.3	163.5
4. Nitrogen + phosphorus (139 + 139 kg/ha)	113.3	141.0
5. Nitrogen + phosphorus + potassium (139 + 139 + 139 kg/ha)	113.6	177.0
6. ½ NPPK	102.5	156.0

Table 2 represents 3 years' average data being characteristic for the changes of *Fertődi 293*, — expressed in the percentage of the untreated control. According to the data of the Table the N top-dressing applied purely (unilaterally?) increases considerably the values of protein, wet gluten, Zeleny number and Farinographic value, thus, it has an improving effect. On the other hand, it is dissatisfactory because of the maximum increase in the ratio of bread form and the expansiveness of gluten. The unilateral application of phosphorus as top-dressing has not caused considerable changes in the variety *Fertődi 293*. Applying NP as top-dressing it has exerted a favourable combined effect. It has increased, to a limited extent, the wet gluten, the Zeleny number and the index of Farinogram, on the other hand, it had a more advantageous effect on the ratio of bread form and on the values of gluten expansiveness than by applying pure nitrogen. NPPK has proved to be of almost the same effect.

Table 2

Changes of the quality characteristics in the wheat variety Fertődi 293 as expressed in the percentage of the control

Martonvásár, 1964, 1965, 1966

Treatment	Crude protein %	Wet gluten %	Zeleny value	Gas retaining capacity, min	Farinograph index	Volume of bread, cm^3	Water absorbing capacity %	Ratio of bread form	Gluten expansiveness, mm	Hull content %
3 years' average of the control in absolute values	13.20	39.40	34.0	38.1	52.7	355.5	62.0	2.0	8.3	12.00
1. Control	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2. N	110.5	113.5	112.4	121.4	119.3	100.5	101.8	130.0	156.2	102.1
3. P	101.8	99.7	96.7	107.4	107.1	101.1	100.5	107.6	100.5	107.1
4. NP	110.7	108.3	107.7	125.2	105.6	105.3	103.6	107.9	101.1	107.0
5. NPPK	109.1	111.0	106.8	114.4	126.7	109.0	103.5	109.5	108.7	109.2
6. ½NPPK	105.2	107.0	109.4	112.8	110.6	104.5	102.0	92.6	121.0	103.1

Table 3 shows 2 years' mean values of the qualitative characters of the variety *Bezostaya 1*. It is conspicuous that, when applying N as top-dressing, the protein content and the quantity of wet gluten were increased in a smaller degree with the variety *Bezostaya 1* having less protein content, than with the variety *Fertődi 293*. At the same time the ratio of bread form and the gluten expansiveness values increased considerably viz., they got deteriorated. It can be also observed that when applying P, the quantity of protein decreased as compared to the control and yet, it was that treatment by which the greatest bread-volume was obtained in the case of *Bezostaya 1*. — Under the influence of P the ratio of bread form and the index of gluten expansiveness have also developed favourably. The fertilizer NP was far from exerting as favourable an effect on the quality of *Bezostaya 1* than on that of *Fertődi 293*. The full fertilizing (NPPK) was very favourable for the quality of the variety *Bezostaya 1*. Unfortunately, the hull content has considerably increased on the effect of NPPK. On the other hand, the effect of 1/2 NPPK treatment is much slighter.

Table 3

Changes of the quality characteristics in the variety Bezostaya 1 as expressed in the percentage of the control

Martonvásár, 1965—66

Treatments	Crude protein %	Wet gluten %	Zeleny value	Gas retaining capacity, min	Farinograph index	Volume of bread, cm³	Water absorbing capacity %	Ratio of bread form	Gluten expansiveness, mm	Hull content %
2 years' average of the control in absolute values	12.14	33.69	33.0	210.0	65.3	414.0	63.5	1.85	2.3	9.67
1. Control	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2. N	101.7	104.6	104.4	74.4	97.4	95.9	100.0	116.3	142.4	101.3
3. P	99.0	101.8	105.3	89.4	92.7	109.0	100.0	91.9	97.2	106.1
4. NP	101.3	104.8	101.4	75.8	95.6	98.4	100.4	107.8	126.2	110.1
5. NPPK	106.8	105.9	105.3	116.6	114.4	102.3	100.4	102.4	111.3	108.9
6. ½NPPK	100.4	102.2	97.3	111.1	111.6	94.0	100.4	99.8	90.5	108.0

Table 4

Grain-yield and the complex qualitative index

Martonvásár, 1963—66

Treatment	Fertődi 293		Bezostaya 1	
	Grain-yield, q/ha	Complex qualitative index	Grain-yield, q/ha	Complex qualitative index
	in % of the untreated control			
Untreated control, absolute values	35.5	92.6	34.0	156.0
1. Untreated control	100.0	100.0	100.0	100.0
2. Nitrogen (139 kg/ha)	101.9	114.4	116.5	86.5
3. Phosphorus (139 kg/ha)	105.6	98.5	102.7	104.8
4. N + P (139 + 139 kg/ha)	111.8	122.3	127.6	90.3
5. N + P + P (139 + 139 + 139 kg/ha)	119.1	122.6	129.2	113.4
6. ½ NPPK	129.8	110.6	118.6	100.0

The values of the grain-yield and of the complex qualitative indices have been compared according to the treatments in the average of the years (Table 4). The highest grain-yield and the highest complex qualitative index have developed on the effect of applying the full fertilizer

NPPK. The data prove that the greater grain-yield is of better quality. Thus, the negative correlation between grain-yield and quality is far from being valid in general.

*

Prepared by the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár.

Zs. Pollhamer

REFERENCES

Koltay, Á. (1964): Intenzív (és extenzív) búzafajták termesztési feltételeinek vizsgálata [The Examination of the Growing Conditions of Intensive (and Extensive) Wheat Varieties]. MTA Mezőgazdasági Kutató Intézete, Martonvásár, Évi jelentés (Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár. Annual Report). II. 129—179.

Koltay, Á. (1965): Búza agrotechnika (Cultural Practices in Wheat Growing). MTA Mezőgazdasági Kutató Intézete, Martonvásár, Évi jelentés (Agricultural Research Institute, Hungarian Academy of Sciences, Martonvásár. Annual Report), III. 411—416.

Koltay, Á. (1966): Búza agrotechnika (Cultural Practices in Wheat Growing). MTA Mezőgazdasági Kutató Intézete, Martonvásár. Évi jelentés (Agricultural Research Institute, Hungarian Academy of Sciences, Martonvásár. Annual Report).

Pollhamer, Zs. (1967): The Complex Qualitative Index of Wheat. Acta Agr. Acad. Sci. Hung. **16**, 339—344.

GERMINATION-RETARDING EFFECT OF PHENOTHIAZINE DERIVATIVES ON WINTER BARLEY

The phenothiazine or thiodiphenylamine derivatives belong to the group of tranquillants in pharmacology (Issekutz 1951). Cerebral-body and the extrapyramidal system are mainly affected by them primarily, they diminish excitability in the centre of heat-regulation and metabolism, most probably by decreasing the oxidative phosphorylation and the activity of ATPase.

With full knowledge of their general effect on metabolism, it has been examined whether they exert influence on one of the most sensitive physiological processes of plants: germination.

For experimental work the *Lédeci Beta* winter variety of barley has been chosen, — a plant being sensitive to germination retarding and stimulating substances.

The compounds with phenothiazine skeleton being used for our investigation, were the following: 3-chlor-N/3'-dimethylaminopropyl/-phenothiazine hydrochloride *(Hybernal)*; N/2 dimethylaminopropyl/-phenothiazine hydrochloride *(Pipolphen)* and L-3-metoxy-N(2'-methyl-3'-dimethylaminopropyl)-phenothiazine hydrochloride *(Tisercin)*. These compounds were used in watery solutions of 0.5, 1.0 and 0.01 per cent. Germinating was performed in Petri-dish, on filter-paper, in polikeit germination-box, at 24° C, in 3×100 repetitions.

It has been examined to what extent the germinating power of the barley grains is influenced by these compounds used in the above-mentioned concentrations and after being wetted for different periods of time.

The germination stimulating effect of gibberellines and auxines is well known (Pozsár 1964). The neutralization of the effect of retarding compounds has been tried with these, too, and it has been found that the germination inhibiting effect of the phenothiazine derivatives examined was not influenced even by the wetting treatment performed, after washing out with 0.01 per cent indolacetic acid and with 0.01 per cent gibberellic acid; the treatment lasted

Ten days after wetting germinating power (%) was the following

Solution-concentration Time of treatment	1% 2 h	0.5% 2 h	0.01% 2 h	0.01% 10 h
Hybernal	0	1	48	24
Pipolphen	0	0	66	21
Tisercin	1	3	69	57
Distilled water	98	98	98	98

for 12 h. Thus, it has been established that compounds of phenothiazine skeleton, inhibit the germination of winter barley. In a concentration of 0.5 and 1 per cent the retarding effect is nearly of 100 per cent; in a concentration of 0.01 per cent it is between 20 and 70 per cent depending on the compound and the time of wetting.

*

Prepared by the National Institute of Agrobotany, Tápiószele.

L. Szabó, E. Haits

REFERENCES

Issekutz, B. (1959): Gyógyszertan (Pharmacology). Medicina Könyvkiadó, Budapest.

Pozsár, B. (1964): A serkentő és gátló vegyianyagok gyakorlati alkalmazása a termelésnövelésben és tárolásban (The Practical Application of Stimulating and Retarding Chemical Substances in Increasing Yield and in Storage). Témadokumentáció (Theme Documentation), OMgK, Budapest.

PHARMACEUTICAL ASPECTS OF THE LIME-TREE

Our well-known and popular lime-trees are being ranked among the valuable plants not only because of their fragrant and honey-producing blossoms, for their wood being used in the furniture- and tool industry, but also for their inflorescence utilized in therapy; previously the parts utilized had been the cortex and the carbo tiliae, then the semen and recently the fatty oil produced from the seed.

The *Tilia cordata* Mill. and *T. platiphyllos* Scop. used to be considered holy trees by certain ancient people. Thus, the Slavs, Northern people and the Russians offered them to the Goddess of love (Ostara, Frigga, Krasogani); they were planted in holy groves, at the main square of villages or towns, at market-hills and in cemeteries. The tree was thought to give protection against thunderstrokes while the parts of the plants were applied to avert pains and illnesses, and they were even being worn as amulet. It was considered to be the tree of spring, of joy and of love. Old people took it for the tree of law and transactions as it was under the lime-tree that the assembly or the tribe gathered. Here problems were discussed and even justice was administered.

The blossom of the lime-tree, mentioned nowadays as official drug in almost every European pharmacopoeia, has been used, most probably, since the Middle Ages only. The Reverend Mother Hildegard (1098—1180), Albertus Magnus (1193—1280) the great scholar, Valerius Cordus (1515—1544) one of the "patres pharmacognosiae" mention the Flos Tiliae. Leonhard Fuchs (1504—1566) alludes to the antiepileptic effect of it; it is mentioned as early

Fig. 1. Holics drug-jars (Hungarian National Museum of Applied Arts)

as 1571 in the Esslingen taxation; the decoction being used as diaphoreticum, diureticum, aromaticum and anticatarrhale. — The *Aqua tiliae* was first described in Brunswig's work (1500). Previously, its bark including mucilage had been placed on wounds and swellings. From its wood the foregoer of today's *Carbo medicinalis*, the *Carbo tiliae* was produced.

The *Tilia argentea* Desf. (silver linden) being also popular in this country, can be utilized, too, for preparing herb-tea; its blossoms have a stronger fragrance than those of the other two ones. In France it has been used to aromatize champagne since the previous century.

In the Semmelweis Museum of Medical History and in the Museum of Applied Arts there are some beautifully ornamented, valuable, square-formed Holics drug-jars. One of these bearing the coloured coat of arms of the Bishop István Telekessi, is being illustrated here. Telekessi became bishop of Eger in 1699 and due to being loyal to Rákóczi, an action was brought against him. He died in 1715. These precious drug-jars come from the former Jesuits' drug-store (Preszler's pharmacy). The drug-store was founded by Telekessi in 1708, and the partly broken vessels were replaced, in 1750, by white tin-glazed jars with baroque label and metal cover; the jars were produced in the Holics factory in the county of Nyitra. The factory had been founded by Ferenc de Lorraine. It was operating till 1827 and contributing to a high degree to Hungarian ceramics through very beautiful and precious products.

J. Halmai

ISOLATION OF LEAF AND PROPAGATION BY CUTTING IN THE WHITE-FLOWERED TRADESCANTIA (TRADESCANTIA ALBIFLORA)

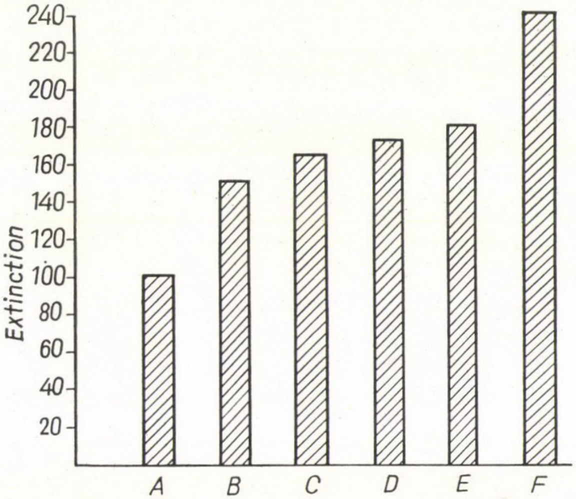


Fig. 1. **Enzyme activity values measured after the 3rd day of isolation. (Averages of the second minute extinction.) A = Plant with root; B = Scion from the tip; C = Surface of the leaf turned downwards; D = Reverse of the leaf turned downwards; E = Surface of a leaf cut into two, downwards; F = Reverse of a leaf cut into two, downwards**

After having removed the roots, the processes of metabolism change in the leaves of the scions. The chlorophyll- and protein content diminish, the enzyme activity becomes enhanced, while the level of free amino acid, ammonia and amide increases (Chibnall—Wiltshire 1954, Kisbán *et al.* 1964, Udvardy—Horváth 1964, Lasztity—Horváth 1965, Horváth—Lasztity 1966). Similarly is enhanced the intensity of respiration (James 1953, Udvardy—Horváth 1964). Martos, in his articles appearing in 1959, gives an account of the change occurring after having detached the roots of seedlings. The present paper is also concerned with the above-mentioned experiments.

The plant of our experiment was the white-flower variety of the green-coloured *Tradescantia.* The detached leaves can be kept, under sterile conditions and at a permanent temperature of 18—20° C, as long as 6 weeks. At 20° C temperature and under greenhouse conditions, the scions will have rooted by the fourth day. When grown under glass, rooting occurs after 6—7 days. In case of propagating by cutting, both the tip and the particles of the stem can be equally made use of. The scions applied were of a length of two internodes, these being between three leaf-pairs. At different periods of time 6 series of experiments have been set with the following variants: A = plant with root; B = scion of the tip kept in water in a beaker; C = detached leaf with its surface downwards on wet filter-paper; D = the reverse side of the leaf on wet filter-paper; E = leaf cut (along the main vein) placed on the filter-paper with the surface; F = cut leaf placed on the filter-paper with its reverse. The detached leaves have been kept in Petri dish. Care has been taken to keep the filter-paper always wet in the Petri dish. The end of the scions has been cut and the water changed every day. Along with paying attention to the different variants the enzyme activity of peroxidase has been measured daily with the photometer Spectromom 201 according to the method of Kisbán *et al.* (1964).

Fig. 1 demonstrates the peroxidase measuring results obtained on the third day after cutting.

It can be seen that, as compared to the control with root, the samples taken from the leaves of the scion also show enhanced enzyme activity on the third day. That of the detached leaves is much higher. In every repetition the activity has been shown to be highest in case of leaves cut along the main vein. The test results could be evaluated the most positively in the reverse part of leaf where stomata take place, these being in contact with the humid filter-paper. In the case of scions kept in water, rooting had started as early as the fourth day. From that time on we obtained the activity values equal to the level of the control with root. As compared to the plant having root, the values obtained in the detached leaves were definitely higher up till the 8th—9th day. The highest value, as shown in Fig. 1, was gained on the third day.

*

Prepared by the Department of Plant Physiology of L. Eötvös University, Budapest.

M. Horváth, E. Sövényházi, D. Lasztity

REFERENCES

Chibnal, A. C.—Wiltshire, G. H. (1954): A Study with Isotopic Nitrogen of Protein Metabolism in Detached Runner Bean Leaves. New Phytol., **53**, 38—43.

Horváth, M.—Lasztity, D. (1966): Pigment Changes in Etiolated Barley Leaves. Acta Agr. Acad. Sci. Hung., **15**, 119—125.

James, O. W. (1953): Plant Respiration. Clarendon Press, Oxford.

Kisbán, K.—Horváth, M.—Dézsi, L.—Udvardy, J.—Farkas, G. L. (1964): The Role of the Root System in the Regulation of Enzyme in Leaf Tissues. Acta Bot. Acad. Sci. Hung., **10**, 275—287.

Lasztity, D.—Horváth, M. (1965): Changes of Pigment in Barley Leaves. Acta Agr. Acad. Sci. Hung., **14**, 321—326.

Martos, V. (1959): Experimental Data Concerning Effect of Plant Roots on Aerial Parts. I. Comparative Investigations into the Effect of the Root System of Various Plants on the Growth of Aerial Parts and the Changes in their Fresh and Dry Weight. Acta Biol. Acad. Sci. Hung., **10**, 1—13.

Martos, V. (1959): Experimental Data Concerning Effect of Plant Roots on Aerial Parts. II. Nitrogen and Phosphate Fractions of the Basal Meristem of Young Wheat Leaves. Acta Biol. Acad. Sci. Hung., **10**, 15—22.

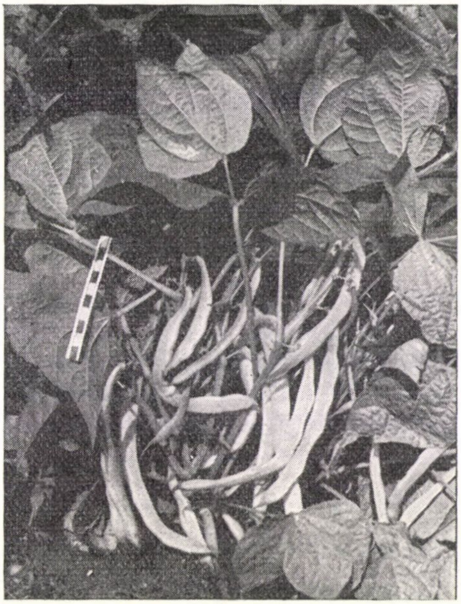
Martos, V. (1959): Experimental Data Concerning Effect of Plant Roots on Aerial Parts. III. Changes in the Amount of Nitrogen Fractions, Free Amino Acids and Nucleic Acids in the Overground Organs of Wheat During Germination. Acta Biol. Acad. Sci. Hung., **10**, 156—167.

Martos, V. (1959): Experimental Data Concerning Effect of Plant Roots on Aerial Parts. IV. Inhibition of Nucleic Acid Metabolism of Roots. Acta Biol. Acad. Sci. Hung., **10**, 169—178.

Martos, V. (1959): Experimental Data Concerning Effect of Plant Roots on Aerial Parts. V. Nutritional Experiments with Isolated Leaf Culture. Acta Biol. Acad. Sci. Hung., **10**, 179—186.

Udvardy, J.—Horváth, M. (1964): A gyökérrendszer szerepe az árpalevél oxidatív anyagcseréjének szabályozásában (The Role of the Root System in the Regulation of the Oxidative Metabolism in Barley Leaves). Botanikai Közlemények, **51**, 109–117.

BUDAI PIACI BOKORBAB
("Budai piaci" Dwarf Bean)



Systematical place: Phaseolus vulgaris L. ssp. *vulgaris* var. *nanus* ASCHERS (MANSFELD 1962).
Origin: From the crossing of Gödöllő × Frühe Wax.
Beginning of breeding: 1955, Budapest—Budatétény.
Breeders: KÁLMÁN CSATÁRI-SZÜTS and ÁGNES BARANYAI, Research Institute for Horticulture, Budapest.
State qualification: Preliminarily certified improved variety, 1961 (KAPÁS *et al.* 1965).
General characterization: A very early maturing dwarf bean with high yielding capacity, excellent for marketing, having yellow pods.

Morphological description:

Root system: finely developed tap root system.
Shoot system: medium high, slender, stiffly upright.
Foliage: light green; the leaflets are elliptical with pointed ends.
Flowers: their corolla is white.
Fruit: when ripe for marketing, it is an 18—30 cm long, 13 cm broad and 9 mm thick straight pod with flattened cross-section, being positioned high on the shoot system. Average pod-weights at the 1st gathering: 8.3 g, at the 2nd picking 6.1 g and on the 3rd one: 4.4 g (SZÜCS 1965).
Seed: kidney-shaped, medium large, white.

Biological characters:

Germination: Under favourable conditions germination is quick, emergency: about 12 days.

Vegetation period: from sowing to flowering 39–44 days, from flowering to market ripening 19 days; length of vegetation (sowing-market ripeness) averagely 58 days (SZÜCS 1965).

Water requirement: it does not require much water and tolerates drought very well (KAPÁS *et al.* 1965).

Resistance to diseases: it is resistant to bean anthracnose being, however, slightly susceptible to haricot-disease and to mosaic virus (SZÜCS 1965).

Farm technology requirements: sowing is performed in the early days of May, the spacing being 40 cm×5—6 cm. The picking of pods is preferable at a tender state of market ripeness since being overripe they become somewhat tunicated and slightly fibrous (KAPÁS *et al.* 1965).

Productivity: Under Hungarian conditions it surpasses all yellow-pod varieties regarding yield. The average yield is 52—86 q/ha. 90 per cent of the crop meets the demands of the market standard. From the viewpoint of the canning industry the colour and taste of the pods are excellent and as to deep-freezing, it is also suitable (KAPÁS *et al.* 1965, SZÜCS 1965).

Region of cultivation: All over the country it can be grown efficiently on sandy clay soil or on brown sandy soil (KAPÁS *et al.* 1965).

GY. MÁNDY

REFERENCES

GABRIEL, A. Mrs. (1963): Bokorbab (Dwarf bean). Nemesített növényfajtákkal végzett Országos fajtakísérletek eredményei 1962 (Results Obtained by Variety Experiments with Improved Varieties 1962), Mezőgazdasági Kiadó, Budapest, 297—312.

KAPÁS, S. *et al.* (1965): Minősített növényfajtáink (Certified Plant Varieties of this Country). Mezőgazdasági Kiadó, Budapest, 92.

MANSFELD, R. (1962): Vorläufiges Verzeichnis landwirtschaftlich oder gärtnerisch kultivierter Pflanzenarten. Akademie-Verlag, Berlin.

SZÜCS. Á. (1965): Zöldfogyasztású bokorbabfajták vizsgálata (Examinations of Dwarf Bean Varieties for Being Consumed in their Green State). Agrobotanika, **6**, 113—123.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 281—282 (1968)

CHRONICA

MIKLÓS BITTERA
(1887—1947)

Miklós BITTERA was in this country one of the prominent representatives of the crop-science in the first half of the XXth century. His name due to his wide-range literary and educational activities was popular not only to his students but known by the agricultural people of the whole country.

M. BITTERA was born in Pozsony on the 12th of November 1887. It was here that he started and also finished his secondary school studies passing his final examination in modern sciences and that of the human gymnasium almost at the same time. He continued his studies at the Law-College in Pozsony and, simultaneously, at the Magyaróvár Agricultural College. He graduated in 1908 and next year, in 1909 he became Doctor of Political Sciences. In order to complete his studies, he went to Geneva where he mainly studied economics.

As early as being a university student, he had mostly been interested in economical and social problems of agrarian character. His diploma thesis as well as his seminary paper in Geneva, were also written in this domain.

After a short period of service in public administration, he became in 1910 a graduated student first at the Economy Chair and later at the Crop-production Chair of the Agricultural College in Kolozsvár. In 1914 he came as an assistant professor to the Agricultural College in Debrecen. It was from here that he joined the army after the outbreak of World War I. As an air force officer he was severely wounded and, being declared 75 per cent invalid, he was discharged from military service in October 1918. This war-injury of his has — however — broken only his body, the spirit has been left as vivid and active as it used to be previously.

In the year 1919 he went to Magyaróvár as an assistant professor, then professor and head of the chair for Crop Science. Here, he showed many-sided activities as while a teaching professor, he took an active part in the work of the Agricultural Association of Farmers of the county Moson; acting first as a secretary, later director and finally as the president of the

Association. In collaboration with Béla GRÓF he has founded the scientific review called "Sugar beet". In the year 1927 he was qualified as a university honorary lecturer with his dissertation "Fertilizers and Fertilizing". From this time on he regularly delivered lectures at the agricultural faculty of the University of Economics and, afterwards, in the domain of "Crop Production Policy" at the Technical University. He had been working constantly almost up to his death on March 11, 1947.

His literary activity was very vast. Altogether 1037 publications of his have appeared in the field of plant growing and the organization of production. Besides these, 32 original books or greater publications are the proofs of his extensive literary activity. Of these the most important are the two volumes of his book: "The Crop Science" which ran into two editions. His works written on fertilizing and on crop production policy are also of considerable importance. In that latter field his work has been of pioneering character.

Besides scientific and higher educational work, he devoted a considerable part of his activity to working for the Agricultural Association of Farmers, to holding courses and popular agricultural lectures, organizing competitions and exhibitions. In spite of being seriously invalid, his agility and working capacity was amazing and this might serve as an example for the young generations.

I. I'só

Acta Agronomica Academiae Scientiarum Hungaricae 17 (1—2), pp. 283—289 (1968)

RECENSIONES

A. Somos, L. Koródi: *Korai szabadföldi paradicsomtermesztés* (Field Production of Early Tomato). Akadémiai Kiadó, Budapest 1967.

In the year 1967 the Akadémiai Kiadó issued the above work consisting of 9 chapters on 135 pages, in 1400 copies, of A/5 size, and in an extremely fine get up. The authors make us acquainted with what is to be known about the field production of early tomato based on the results of the most recent domestic and foreign research work.

In the order of chapters, a review of the book is presented herein, as follows:

In the first chapter entitled "The Situation in the Production of Early Tomato", the growing data of some European countries and those of the most important tomato producing states are submitted; the data on domestic tomato growing and on the raw exports covering several years, are shown in Tables and demonstrated graphically. Authors call the attention to the changing requirements of raw export, and to making use of the feasibilities by applying new varieties and growing methods.

In Chapter II particular information containing new data, is presented on the growing and economic conditions, i. e. heat-, light-, water- and nutriment-requirements of early tomato. In a separate subchapter authors are emphasizing the viewpoints to be considered when choosing the areas suitable for growing early tomato. The importance of economic motives and operating conditions are also taken into consideration.

The properties that should be considered when choosing the varieties suitable for early production, are fully discussed in Chapter III.

Chapter IV submits ample information on what is to be known concerning propagation. Authors make us acquainted with the main aspects of establishing and equipping a modern nursery-garden; they describe the ways of seed-testing, the treatment before sowing and, on the basis of several years' experimental series, they inform us on the methods and technique of growing seedlings. Finally, examples are quoted regarding the utilization of the nursery-garden.

In Chapter V the place of early tomato in the rotation, the manuring and soil-preparation are discussed.

Chapter VI contains data concerning the determination of spacing as well as bedding out seedlings, their transport and re-planting.

In Chapter VII when discussing the works required in nursing, we find those of protection against belated frosts, the enumeration of methods promoting earliness and, finally, what to do for plant protection.

Chapter VIII discusses the subject of picking and marketing, detailed, as follows: the grade of maturity, the frequency of picking, manual and mechanized picking, classification and packing.

Finally, Chapter IX shows, on the basis of the data presented by the Estate of the School for Horticulture and Viticulture, the tendency of productions-cost in growing early tomato.

The text is made more descriptive and understandable by 44 excellent Figures and 42 Tables.

When summarizing, it can be established that the authors who are experts in growing early tomato, have tried to hand down their extensive and scientifically established knowledge for practical usage.

GY. MÉSZÖLY

M. P. CATO: *De agri cultura.* Scriptores Graeci et Latini 11. Akadémiai Kiadó, Budapest 1966.

Those devoted to ancient culture as well as agricultural scientists equally appreciate the bilingual (Latin and Hungarian) publication of M. P. Cato's work: "De agri cultura" (On Agriculture). Since of that book only selections have appeared in Hungarian translation so far (cf. Világirodalmi Antológia, — World Literature Anthology, I. 1952), this one is the first venture to have the complete work published.

The literary value of Marcus Porcius Cato's book (234–149 B. C.) lies in its being the first Latin prose dating from the beginning of the Roman literature that has remained in its complete text; and as being also the first document of Italian agriculture, it deserves attention because of its subject, too. The spurring effect of the book is shown by the fact that, as a result, there developed in Rome considerable agricultural special literature being hall-marked by the names of Varro, Vergilius, Columella, Plinius Maior. The remarkable personality of the author has called the attention of the ancients, too. One of the characters in Terentius' comedy Adelphoe (Brothers) makes us presume that it is a satyric portrayal of Cato. But we meet him also in Cicero's "De senectute", (On Agedness), and also in the work of Plutarchos: Parallel Biographies. Just as the ancient writers do not show a uniform attitude in judging Cato's character, there is to be found many a contradictory opinion in Cato's portrait drawn by modern researchers (MOMMSEN, GUMMERUS HEICHELHEIM). Recently D. KIENAST in his short monography under the title: "Cato der Zensor. Seine Persönlichkeit und seine Zeit". (Heidelberg 1954), tried to solve these contradictions. In the introductory treatise of the Hungarian publication of "De agri cultura" (On Agriculture), EGON MARÓTI endeavours to apprehend Cato's dynamic personality as contrasted to the static Cato-portraits that have been known up till now and that might be considered, with right, objectionable. E. MARÓTI describes that Cato whose views "have not remained untouched by various divergent effects in the succession of stirring times" (E. MARÓTI: Cato and the work "De agri cultura"). The introductory essay, however, does not refer to and is not restricted to Cato's personality only, — as in KIENAST's book. In his monograph, the latter is unjust when speaking so little about "De agri cultura"; starting from the exhaustive analysis of the work, MARÓTI submits the economic features of the age.

But let us see what that work tells the economist-historian. As already stressed by JENŐ TOMASZ in his book titled "A római földkérdés" The Roman Land-problem (Parthenon, Budapest 1943), in the course of the 2nd Punic war and the following expansions in the East—West direction, a new economic situation was being developed in Rome. The area of the Empire became ten times her previous size; through conquests huge fortunes streamed into the Empire. The unpaid slave-workers meant a heavy blow on the existence of the Roman smallholders and of the free agricultural workers. The petty peasant properties became more and more replaced by the large estates (latifundia) producing goods. Though Cato makes his appearance as a protector of the ancient Roman traditions against the Scipio-circle expressing the Greek mentality, and though his view of life reflects the hard and toilsome life of the Italian small-holder, nevertheless, by the mentality of "De agri cultura" he becomes a propagator of that new-type economy the aim of which was the producing of goods. This is referred to by the fact that when purchasing an estate, Cato considers important the neighbourhood of a large city (thus rendering good possibilities for marketing)! His principle is: "*Patrem familias vendacem, non emacem esse oportet*" (The owner of the house should rather be willing to sell than to purchase) ("De agri cultura", 2,7). The farming as accepted by Cato is no more a farm covering the household demands ("oikos"); the estate is directed by the "vilicus" (farm manager), and slaves do the work in the vineyards as well as on the olive-plantations. The tendency of the book seems to support the establishment concerning the new-type farm. Among others, Cato summarizes his agricultural experiences in a theoretical work with the view to make the Italian landowners acquainted with more profitable processes.

Because of the very loose structure of the book, the systematical arranging is very difficult, however, some coherent groups of subject can be observed: In the introductory chapters Cato deals with general problems: what has the farmer to keep in mind when purchasing an estate; what are things the farmer has to do, etc. We also find information being important from archeological point of view, and those referring to farm-buildings, equipments and working tools. The findings explored in Pompeii and in the neighbourhood, do not contradict the above data. Though Cato deals also with field cultivation (cf. the rotation system in Chapter 27), nevertheless there are two main subjects that come into prominence in his book: those of grape- and olive growing and the processing of same. That concentration of the subject also makes clear a process taking place in Cato's days: due to the low price of grain streaming in during the conquests, the growing of grain became no more profitable and, therefore, was replaced, more and more, by horticulture in Italy (first, on the large estates where the necessary equipment could be provided for!). Egon Maróti, in his essay, comes to similar conclusion when examining the sequence of utilization of the various estates as established by Cato (cf. "De agri cultura", 1,7).

On the basis of Cato's description we get a vivid picture on soil cultivation, on the kinds of manures, on the propagation of olive, grapes and fruit-trees, and on the ancient methods of pruning, trimming, grafting, budding, etc. From professional viewpoint, the latter two phenomena deserve special interest because of their not being distinguished enough by the terms Cato uses for them. Cato describes three ways of grafting vines, two of which agree with the whip-graft and grafting by approach known in modern practice. In the third method, however, we might observe a special combination of whip-graft and the layering (cf. "De agri cultura", 41, 1, 2, 3, 4). It has to be noted that in ancient times grafting was applied only as a method of vegetative propagation.

In connection with viticulture we get acquainted with two Italian types of vine plantation: the "arbustum" (vineyard in which vines are trained on trees) and the "vinea" (in which case the runners of the vine are trained on a trellis or grops). The vine varieties are given names by Cato partly after the place where they are grown, partly after their properties, e.g. Aminaea, Murgentia, Luciana, bee-vine, etc. The book contains many references to oenology. Detailed descriptions are submitted on oil-processing and on various kinds of oil. It would be rather lengthy to enumerate the numerous applications of the "amurca", the scum of oil; Cato advises to use it against grain-weevil, the sheep getting scabious, against the caterpillars damaging the grapes as well as for making the oil-trees more fruitful, etc. Animal breeding does not play an important role in the book; author mainly writes about the tending of oxen and on preventive measures against illness.

These few subjects mentioned also allow us to see that the book offers rich sources not only for the economist-historian but also for the agricultural expert in examining some problems of natural sciences, also of historical point of view.

The publication of Cato's "De agri cultura" required great philological care. The ancient work was kept and safeguarded by the Florentinus Marcianus codex that used to be the property of the St. Mark library in Florence, however, later it got lost. The modern publications avail themselves of the different interpretations as well as the direct or indirect copies of same. In the Hungarian issue the basis of the Latin text is the most modern publication of Cato's "De agric ultura" appearing under the editorship of A. MAZZARINO. (Bibliotheca Scriptorum Graecorum et Romanorum Teubneriana. Lipsiae. 1962.) Where the translator takes into consideration versions divergent from this, — we find the same version in the Latin text, too. (cf. SZÁDECZKY-KARDOSS SAMU: Megjegyzések a latin szöveghez) (Observations on the Latin text). The Hungarian interpretation of "De agri cultura" is the merit of JÓZSEF KUN. In the translator's work the usage of proper agricultural expressions (if necessary, he helps us to understand these with the aid of rich annotation), Cato's mentality and the archaic (but not archaising!) zest interpreting his concise language, must be emphasized. The notes are made expressive with the help of a rich collection of pictures. These are mainly photocopies on material remains of ancient agriculture (especially findings from Pompeii) and partly rough reconstructions made about farming implements of Cato's days like e.g. the cross-sectional picture of the oil-mill ("trapetum").

Summarizing: We are only too pleased to welcome such a publishing approach according to which not only belletristic writings but also works of agricultural character are included among the volumes of the Scriptores Graeci et Latini issued by the Akadémiai Kiadó (Publishing House of the Academy of Sciences). Therefore the P. H. A. S. is warmly recommended to contribute, even with an increased purposefulness, to reveal ancient literature referring to natural sciences; this would render our knowledge of antiquity more perfect and would also submit easily accessible sources needed to work up, historically, the problems of natural sciences.

M. CSERNÁK

SZ. SCHERMANN: *Magismeret* (Knowledge on Seeds). Akadémiai Kiadó, Budapest 1966. I. 861, II. 100 Tables.

In the last days of the past year a vast and very important work was published; this work is a great asset both to agriculture in a wider sense and to theoretical botany.

SZILÁRD SCHERMANN, author of the book, has spent his life from 1923 up to his recent retirement at the State Board of Seed Control (Formerly: the Station for Seed Examination) and as a result of his activities throughout four decades, he has now compiled his rich theoretical and practical experiences.

The book meets a long felt need as, besides the work of BRECHER being translated from Slovak and published in 1960 as well as that of DANISSKA–BAGI–ANTAL issued in 1965, no important book of comprehensive character has appeared so far in that special field though dealing with particulars, quite a number of essays have as well been written by Hungarian authors.

Comparing SCHERMANN's book with the literary products on international seed problems, it can be established that the author has produced — even in this comparison — an exceedingly good and original work.

As a matter of fact WITTMACK (1922) does not submit in his work the general outlines on seed types, he only describes the genera in the families and within these, the species. The work of the Soviet author DOBROCHOTOV appearing in 1963 and containing 50 coloured Tables, comprises the description of 730 plant species, first of all that of weeds. The most complete European work published so far in this domain is that of BROUWER–STÄHLIN (1955) entitled "Handbuch der Samenkunde" which describes more than 2500 species giving, however, the picture of only two-third of them and this is mostly in one Figure that shows merely the contour of the seed. The high number is made up by the fact that author has included in his work 900 soft-stemmed ornamental plants as well as 200 exotic trees and shrubs.

If comparing SZILÁRD SCHERMANN's work with the above, it appears that though he has decreased the number of ornamental plants discussing only 230 herbaceous and 100 ligneous ones, — he describes, on the other hand, the seed of 120 indigenous species being grown in the field, 80 horticultural species; 50 exotic plants grown in the field, 110 wild-growing ligneous, 650 soft-stemmed species growing wild; besides, the description of the seed of 360 indigenous weeds and 100 exotic weeds indicating the origin is also given.

Author dedicates his work to the memory of ÁRPÁD DEGEN on the occasion of the centenary of his birthday. Nothing worthier could have been written in memory of his Master who was an internationally acknowledged personality of Hungarian seed examination.

After the "Preface" comes the "Introduction" in which the author makes us acquainted, besides setting his objective, with the necessary basic ideas. He discusses the flower and the fruit that is being developed; then comes the classification of fruit; the relation between seed and plant-embryo; the form and size of the seed as well as its surface. Then follow the most detailed literary references being grouped according to chronological sequence.

The second part of the work discusses the groups of types and the taxonomic keys. First he discusses the problems of the grouping suitable to determine the seeds and fruits being of seed-value (i.e. the non-dehiscing dry fruit having one seed and the non-dehiscing fruit-particles of the disintegrating fruit). He then describes the taxonomizing experiments applied so far. After this he goes on making us acquainted with his own systematization of types and the basic key for type-groups the basis of which the author considers the size, scale relations, symmetry-relations of seeds and fruits being of seed-value. This is followed by the individual characterization of 16 type-groups, the Tables of seeds being classified into that frame and the dichotomic taxonomy key.

The third and most comprehensive part of the work is entitled: "Detailed Knowledge on Seeds in the Frame of Taxonomy".

Here, besides the description and the taxonomic key of the families, there follows a detailed description of each seed. With each species, the Latin, Hungarian, German and English name of the plant are to be found, while after the morphological characterization of the seed, reference is made on the taxonomic key and comments are made referring to the circumstances of occurrence. That part contains the determination of the seed of altogether 1800 serialized species on 542 pages.

Vol. II submits, in altogether 100 Tables, the picture of all seeds in such a way as the seed and fruit, respectively, should be recognizable and identifiable. Therefore, not contours but pictures are shown in most cases not only front-wise but also from the side, from above and also in cross- and vertical section according to the manner and extent required by the determination.

As a basis of the taxonomic sequence of species the author availed himself of the work of SOÓ–JÁVORKA: "A magyar növényvilág kézikönyve" (Manual of the Hungarian Flora) (1951) taking, however, into consideration the changes prevailed so far in nomenclature. We have to lay a stress on his applying the special taxonomic categories having been introduced these years, for assigning the taxonomic units within the species of cultivated plants.

When studying the work we might establish that the theoretical basis of type-grouping is the author's original idea and thus it is also a novelty for science. Individual and original work of the author is the elaborating of taxonomic keys, the detailed description of the seed and especially the competent designing of 1800 seeds shown in 100 Tables. All this proves the wide and profound knowledge of the author who has treated that vast material without fail, with utmost certainty due to his long practice in seed examination and on the basis of his research work in this field.

I should like to emphasize another great merit of the work. For quite a long time the science of botany and the practice in plant growing had been more independent from each other than was right, the result of which was the development of very diverse and often even contradictory terminologies. Due to the great improvement in agrarian higher education carried out mainly in recent times, these divergencies are going to disappear almost entirely and are to be found rarely, here and there only. Author has solved this problem when finding the ways to have also the practical experts being used to the older school, to understand that work thoroughly though agreeing with the most modern botanical terminology.

The vast, detailed and original book being the chef d'oeuvre of the author, is a great contribution to the plant growing and botanical special literature of this country. The book is long-needed at home and also high-standing in international relation having the purpose of serving and supporting experts in their work. For that reason the work would deserve being translated in some foreign language thus rendering it possible that SZILÁRD SCHERMANN's oeuvre should become public property at international level, too.

Z. E. KÁRPÁTI

BURTON, W. G.: *The Potato.* A Survey of its History and of Factors Influencing its Yield, Nutritive Value, Quality and Storage. Second Edition. Veenman & Zonen N. V., Wageningen 1966.

Nearly two decades have passed since the time the first edition of this book appeared. During this period our knowledge of all aspects of potato production has tremendously increased. This recent edition made it necessary to subject the first edition to a thorough revision and to supplement it with recent data. The author succeeded well in solving this difficult task and BURTON's book has become again an up-to-date textbook containing all what has to be known about the physiology of potatoes. The work of bringing this book up-to-date was certainly not easy because during the period between the two editions many thousands of papers appeared which were based on original research. It was doubtlessly very difficult and time consuming to work up, to evaluate and to make use of this wealth of information.

In spite of the numerous recent results which had to be included BURTON's book did not increase in volume to a considerable extent. The recent edition amounts to no more than 382 pages and contains 55 Tables and 48 Figures. However, about 20 per cent of the content is taken by literary references, author index and subject index and yet the remaining 308 pages include the scientific evaluation of about 1600 publications.

The 12 chapters and 4 appendices make out 3 parts.

Of the two chapters of the *first* part the first chapter deals with the origins and distribution of the potato (Cultivation in South America; Introduction into, and spread in Europe; Development as staple food in Ireland and rest of Europe; Statistics of production and consumption). The second chapter is concerned with potato varieties (Origin of varieties; Distinction between varieties and their identification; Mutants; Diagnostic characters of common British varieties). The characteristics of the 13 varieties described are summarized in a Table easing thereby their comparison and differentiation. It is regrettable that some other, foreign varieties, at least the most important European ones are not listed. In this way specialists outside England get only a one-sided information. At any rate such a comparison would have been very useful.

The *second* part is divided into 4 chapters. The first chapter deals with the conditions of tuber formation and dry matter production as well as with climatic effects, with the length of the vegetation period, with the right soil type to be chosen and finally with the translocation of organic substances in the plant. The second (altogether the fourth) chapter of this part is about the fertilization of potatoes (Absorption of nutrients from the soil and resultant soil depletion; General principles of manuring; Farmyard manure and its substitutes; Necessary balance of nutrients; Nitrogen; Phosphorus; Potassium; Chlorine; Calcium; Magnesium; Sodium; Molybdenum; Iron; Manganese; Boron; Zinc; Copper). In Chapter 5 the effects of diseases and pests upon the yield are described. The topics of Chapter 6 are the following: source of varietal differences in yield and dry matter, yields and percentages of dry matter to be expected from a number of varieties, source of seed tuber, size of seed tuber, cut seed, seed tuber storage, "little potato", spacing, cultivation and depth of planting.

The *third* part comprises 6 chapters in which the composition, nutritional value, quality and storage of potato tubers are dealt with. The individual chapters are concerned with the following problems. Chapter 7 deals with the distribution and composition of dry matter in the potato tuber, primarily from a histological and chemical point of view, Chapter 8 with the value and composition of nutrients prepared from potato tubers, Chapter 9 with the cooking quality of tubers, the quality requirements as well as with several factors and diseases reducing tuber quality. Chapter 10 is concerned with physiological problems arising after the harvest, mostly with changes in chemical composition, respiration and the effect of temperature. In Chapter 11 tuber diseases emerging during storage are described. In Chapter 12 storage requirements and different modes of storage are dealt with.

At the end of the book there are four appendices. Appendix I contains the original description of potato as published by GERARD (1597), Appendix II the industrial use of potato. In Appendix III the correlations between the specific weight, the dry weight and the starch content of the tuber are listed, whereas Appendix IV is a conversion table relating British and decimal units. The valuable content is concluded by ample references as well as by a subject index and an author index.

GY. MÁNDY

INDEX

VARIA

CHRONICA

RECENSIONES

XI. International Botanical Congress

The XI. International Botanical Congress will meet at the University of Washington, Seattle, Washington, U. S. A., from August 24 to September 2, 1969. The First Circular giving information regarding the Congress has already been mailed to more than 40,000 individuals and organizations. If you wish to receive one, write to:

Dr. Richard S. Cowan, Secretary
XI. International Botanical Congress
3900 Wisconsin Avenue, N. W.
Washington, D. C. 20016, U. S. A.

Although the First Circular indicates December 1, 1967 as the date by which preliminary registration must be returned, inquiries and registrations after that date will be welcome.

“Probleme agricole”

is a periodical of agricultural science and practice, published in Rumania as an organ of the Higher Council of Agriculture and destined to the specialists in agriculture with higher studies.

The review publishes works concerning the problems of the development of the agricultural production (original researches, papers drawn up on the basis of experiments and of the scientific literature of speciality, achievements of the foremost agricultural units) in the following fields: economy and organization of the production, utilization of the land fund, plant melioration, agrotechnics, phytotechnics, plant protection. The original works are accompanied by Russian, English and French summaries.

The review contains also the chronicles of certain important scientific events and manifestations from Rumania and from abroad, and the reviews of works published in different countries.

DIE ERHÖHUNG DER FRUCHTBARKEIT DER SANDBÖDEN

Vorträge der Internationalen Koordinierenden Arbeitstagung in Budapest 1965

Herausgegeben von M. KOZÁK

Abhandlungen in deutscher und russischer Sprache · 446 Seiten · Zahlreiche Abbildungen und Tabellen · 17×24 cm · Ganzleinen $9.80

Der Band enthält in ungekürzter Fassung sämtliche auf der im Jahre 1965 stattgefundenen internationalen Sandböden-Konferenz vorgelesenen bzw. dazu eingesandten Vorträge. Die Arbeiten der deutschen, polnischen, rumänischen, sowjetischen, tschechoslowakischen und ungarischen Fachleute beschäftigen sich mit den wissenschaftlichen und praktischen Problemen der Erhöhung der Fruchtbarkeit der Sandböden. Sie behandeln die Fragen der Bodenbearbeitung, der organischen und Mineraldüngung, der Bodenmelioration sowie der Bewässerung der Sandböden, und teilen auch die Ergebnisse der bodenphysikalischen, bodenchemischen und anderen theoretischen Forschungen mit, die zur Grundlage der produktiveren praktischen Methoden dienen und deren Anwendung fördern.

CANADIAN JOURNAL OF SOIL SCIENCE

The Agricultural Institute of Canada, organized in 1920, publishes the Canadian Journals of Plant, Animal and Soil Science. These journals are devoted to the publication, in English and French, of the results of original scientific research in the fields of Plant, Animal and Soil Science.

The Canadian Journal of Soil Science is published 3 times yearly, these issues making up a volume of some 400 pages a year, size 24.7×16.5 cm.

The publication charge payable by all authors has been reduced to $25 per printed page; however, free reprints are no longer provided. Price quotations for reprints are provided with the galley proofs, and reprints should be ordered when the proofs are returned to the Editorial Office.

Manuscripts for publication and all correspondence should be addressed to the Editorial Office. Subscriptions are $7 per year, including postage; single copies, $3.50.

Editorial Office — Agricultural Institute of Canada
Suite 907, 151 Slater St.,
Ottawa 4, Ontario.

The Agricultural Institute of Canada also publishes the Agricultural Institute Review, bi-monthly.

HEREDITY

An International Journal of Genetics

Volume 22 AUGUST 1967 Part 3

CONTENTS

Annual subscription £4 (U.S.A. $14.00)
Single part 25s. (U.S.A. $4.00)

OLIVER & BOYD LTD.
Tweeddale Court, 14 High Street, Edinburgh, 1

AGROKÉMIA ÉS TALAJTAN

Quarterly Journal of
Soil Science, Agricultural Chemistry, Fertilization, Soil Biochemistry, Soil Microbiology and Plant Physiology

Published by the Research Institute of Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences, Budapest, II., Herman Ottó-út 15. (Budapest 114. P.O.B. 66) Hungary.

AGROKÉMIA ÉS TALAJTAN publishes papers by eminent Hungarian and foreign scientists in Hungarian, the detailed summaries are translated into English, Russian and a third language, French, German, Spanish or Italian.

The journal is issued four times a year in annual volumes of about 700 illustrated pages.

Distributor: **KULTURA, • BUDAPEST 62. P.O.B. 149.**

Die Acta Agronomica veröffentlichen agrarwissenschaftliche Abhandlungen, besonders aus dem Bereich der landwirtschaftlichen Grundforschung, in englischer Sprache.

Die Acta Agronomica erscheinen jährlich in einem Band (4 Hefte).

Die zur Veröffentlichung bestimmten Manuskripte sind an folgende Adresse zu senden:

Acta Agronomica
Martonvásár, Postafiók 19.

Abonnementspreis pro Band: 165 forint. Bestellbar bei dem Buch- und Zeitungs-Außenhandels-Unternehmen »Kultúra« (Budapest I., Fő utca 32. Bankkonto Nr. 43-790-057-181) oder bei seinen Auslandsvertretungen und Kommissionären.

Les Acta Agronomica publient des communications, en langue anglaise, dans le sujet de la science agricole, surtout du domaine des recherches fondamentales agronomiques.

Les Acta Agronomica sont publiés sous forme de fascicules qui seront réunis en un volume par an.

On est prié d'envoyer les manuscrits destinés à la rédaction à l'adresse suivante:

Acta Agronomica
Martonvásár, Postafiók 19.

Le prix de l'abonnement est de 165 forints par volume.

On peut s'abonner à l'Entreprise pour le Commerce Extérieur de Livres et Journaux «Kultúra» (Budapest I., Fő utca 32. Compte-courant No. 43-790-057-181) ou à l'étranger chez tous les représentants ou dépositaires.

Acta Agronomica публикует статьи по аграрной тематике, главным образом теоретические работы в области сельскохозяйственных основных наук.

«Acta Agronomica» выходит выпусками, составляющими один том в год.

Предназначенные для публикации рукописи следует направлять по адресу:

Acta Agronomica
Martonvásár, Postafiók 19.

Подписная цена «Acta Agronomica» — 165 форинтов за том. Заказы принимает предприятие по внешней торговле книг и газет «*Kultúra*» (Budapest I., Fő utca 32. Текущий счет № 43-790-057-181) или его заграничные представительства и уполномоченные.

27. II. 1968

Index: 26.001

ACTA AGRONOMICA

ACADEMIAE SCIENTIARUM HUNGARICAE

ADIUVANTIBUS

J. DI' GLÉRIA, P. KOZMA, G. LÁNG, V. LÁZÁR, E. OBERMAYER, J. SCHANDL, G. UBRIZSY

REDIGIT

S. RAJKI

TOMUS XVII FASCICULI 3–4

AKADÉMIAI KIADÓ, BUDAPEST
1968

ACTA AGRONOMICA

A MAGYAR TUDOMÁNYOS AKADÉMIA AGRÁRTUDOMÁNYI KÖZLEMÉNYEI

SZERKESZTŐSÉG ÉS KIADÓHIVATAL: BUDAPEST V., ALKOTMÁNY UTCA 21.

Az Acta Agronomica angol nyelven közöl értekezéseket az agrártudomány tárgyköréből, főképpen a mezőgazdasági alapkutatások területéről.

Az Acta Agronomica változó terjedelmű füzetekben jelenik meg, több füzet alkot egy kötetet.

A közlésre szánt kéziratok a következő címre küldendők:

Acta Agronomica
Martonvásár, Postafiók 19.

Ugyanerre a címre küldendő minden szerkesztőségi és kiadóhivatali levelezés.

Az Acta Agronomica előfizetési ára kötetenként belföldre 120 Ft, külföldre 165 Ft. Megrendelhető a belföld számára az Akadémiai Kiadónál (Budapest V., Alkotmány utca 21. Bankszámla 05-915-111-46), a külföld számára pedig a »Kultúra« Könyv és Hírlap Külkereskedelmi Vállalatnál (Budapest I., Fő utca 32. Bankszámla: 43-790-057-181) vagy annak külföldi képviseleteinél és bizományosainál.

The Acta Agronomica publish papers, in English, on agronomical subjects, mostly on basic research.

The Acta Agronomica appear in one volume (four issues) a year.

Manuscripts should be addressed to:

Acta Agronomica
Martonvásár, Postafiók 19.

The rate of subscription to the Acta Agronomica is 165 forints a volume. Orders may be placed with "Kultúra" Foreign Trade Company for Books and Newspapers (Budapest, I., Fő utca 32. Account No. 43-790-057-181) or with representatives abroad.

ACTA AGRONOMICA

ACADEMIAE SCIENTIARUM HUNGARICAE

ADIUVANTIBUS

J. DI' GLÉRIA, P. KOZMA, G. LÁNG, V. LÁZÁR, E. OBERMAYER, J. SCHANDL, G. UBRIZSY

REDIGIT

S. RAJKI

TOMUS XVII

AKADÉMIAI KIADÓ, BUDAPEST
1968

ACTA AGRONOMICA

ТОМ XVII — ВЫП. 3—4

РЕЗЮМЕ

НЕКОТОРЫЕ НАБЛЮДЕНИЯ В СВЯЗИ С ОБРАЗОВАНИЕМ БОКОВЫХ КОРНЕЙ У ФАСОЛИ (*PHASEOLUS VULGARIS* L.)

П. ГРАЦА

В специальной литературе при описании морфологии и детальностей возникновения корня, появление боковых корней обычно называют акропетальным. На основании морфологических и гистологических исследований выявлено, что первые корни фасоли с большой частотой отходят в 2—3 ярусах в таком же направлении, как и семядольные листья (базипетально). Инициация этих корней происходит в зоне корневой шейки, где находятся как простая первичная ксилема, так и характерная для гипокотиля непрерывная проводящая система. После этого на зародышевом корешке ниже уровня корневой шейки ближе к его кончику начинают возникать выраженные акропетально ориентированные боковые корни.

ИЗУЧЕНИЕ ГОЛОВНИ (*USTILAGO SCITAMINEA* SYD.) НА САХАРНОМ ТРОСТНИКЕ (*SACCHARUM OFFICINARUM* L.), ВЫРАЩЕННОМ НА ЛАТЕРИТНОЙ ПОЧВЕ

К. В. Б. Р. ТИЛАК

Было найдено, что вообще максимальная инфекция наблюдалась в июле-августе в оба года. Этот период совпадает с дождливым сезоном в этом районе. Этот период также соответствует началу формирования сахара в стеблях.

РЕЗУЛЬТАТЫ СЕЛЕКЦИИ *LAVANDULA ANGUSTIFOLIA* MILL.

К. ЛЁРИНЦ, Е. ТИХАК

Классическими и современными методами исследовалась коллекция клонов, созданная на основании морфологических признаков выращивавшейся в Венгрии *Lavandula angustifolia Mill.* На основании результатов исследований удалось выделить и размножить новые типы, отличающиеся по качественному составу и более богатые эфирными маслами.

ИЗМЕНЕНИЕ ВЕСА И ВСХОЖЕСТИ СЕМЯН ПШЕНИЦЫ В ПЕРИОД СОЗРЕВАНИЯ

Д. ПАЛ, М. ТАЛЛЕР

Отставание в развитии, проявляющееся у цветков в акропетальном порядке и у апикальных и базальных зачатков колосков при дифференциации, сохраняется и при развитии цветка и зерновки. В процессе созревания зерна прирост веса зерновки и интенсивность его изменяется в зависимости от сорта, ввиду различной реакции сортов на экологические факторы. Интенсивность прироста веса зерна и максимум его достигается

в различные периоды, что зависит от сорта и погодных условий. Семена пшеницы оказались всхожими уже на третий день после оплодотворения, но 90%-ная всхожесть наблюдалась только у 15-дневных зерновок.

ВЛИЯНИЕ НЕКОТОРЫХ НАТРИЕВЫХ СОЛЕЙ И АЗОТОСОДЕРЖАЩИХ СМЕСЕЙ НА ФИКСАЦИЮ АЗОТА *CALOTHRIX* SP.

АМИН С. ЭЛЬ-НАВАВИ, А. Н. ИБРАГИМ, М. АБОУЛ-ФАДЛ

Изучалась фиксация азота местным штаммом голубоватозеленой водорослью *Calothrix* sp. в лабораторных условиях. Na_2S задерживал рост водоросли при концентрации 3180 ppm; NaCl не действовал при концентрации 795 и 1590 ppm, но вызывал сильную депрессию при концентрации 3393,5 ppm. Фиксация снижалась на 50% в присутствии 21 мг азота на 1 л в форме сульфата аммония и аспарагина, и полностью приостанавливалась при 105 мг. В свете полученных результатов дискуссируется фиксация азота на рисовых полях.

ДЕЙСТВИЕ АЗОТИСТЫХ УДОБРЕНИЙ НА УРОЖАЙ КЕНАФА (*HIBISCUS CANNABINUS* L.)

ФАРУК ЭЛЬ—ТОХАМИ ОРАБИ

Урожай зеленых стеблей и урожай волокна увеличивались при применении 100 кг азотнокислого кальция. Однако, применение 200 кг азотнокислого кальция увеличивал и урожай зерна.

СТЕПЕНЬ КРИВИЗНЫ СКОРЛУПЫ КОНЦОВ ЯЙЦА, ВЫЯВЛЯЕМАЯ ООМЕТРИЕЙ, И ВЗАИМОСВЯЗЬ ЕЕ С РЕЗУЛЬТАТИВНОСТЬЮ ВЫВЕДЕНИЯ ЦЫПЛЯТ

О. Б. ЯКАБ, Е. ТАМАШШИ

Использовав введенный в оометрии новый способ измерения кривизны скорлупы была получена более надежная, по сравнению с имевшейся до сих пор, информация (измерение осей, данные, полученные при перекресте осей, профиль-индекс и т. д.) для выборки форм яиц, повышающая результативность инкубации. Измерительные опыты показали обнадеживающую взаимосвязь между кривизной скорлупы концов яйца и результативностью инкубации. Обычно яйца с небольшой кривизной скорлупы задыхаются, а из яиц с большой кривизной цыплята вылупляются. Кроме того ведутся поиски других, независимых от кривизны скорлупы, показателей, которые вместе с этим показателем дали бы определенную основу полезной выборки яиц.

ИЗМЕНЕНИЕ АКТИВНОСТИ ЭНЗИМА КАТАЛАЗЫ У СОРТОВ СТОЛОВОГО ВИНОГРАДА В ПЕРИОД ВЕГЕТАЦИИ

Й. САЛАИ

Взяв за основу определение Новопавловской (1960), нами исследовалось изменение активности энзима каталазы в период вегетации у сортов винограда раннего и позднего созревания, привитых на подвой 5 ВВ. Определено, что в период вегетации изменение активности каталазы испытывавшихся сортов отличается друг от друга, но это не является сортовым признаком. На основании активности каталазы мы не смогли отличить данные сорта.

погодой весенних месяцев и содержанием сухих веществ взаимосвязь сильнее и более вероятна. Повидимому между урожаем и содержанием сухих веществ плодов наблюдается обратная связь.

ТОРМОЖЕНИЕ ФИКСАЦИИ ДВУОКИСИ УГЛЕРОДА И ИНТЕНСИВНОСТИ СИНТЕЗА БЕЛКА В ЛИСТЬЯХ ЯБЛОНИ, ЗАРАЖЕННОЙ *VENTURIA INAEQUALIS*

К-НЕ ДАНЧ, Б. И. ПОЖАР, Б. ФЕРЕНЦ

В данной работе сравнивалась фиксация двуокиси углерода листьями яблони от здоровых растений и зараженных на 30—40% *Venturia inaequalis* (Cke.). Определено, что интенсивность фиксации радиоактивной двуокиси углерода намного меньше в случае, когда состояние заражения прогрессирует. В результате заражения фиксация в темноте характеризуется гораздо большим торможением, чем синтез белка и фотосинтетическая фиксация двуокиси углерода. Под влиянием заражения проявляется торможение фотосинтетической фиксации двуокиси углерода, которое полностью схоже с уменьшением интенсивности биосинтеза компонентов хлорофилла и каротиноида. Отмеченный радиоактивным углеродом глицин, необходимый для включения в белок листьев и являющийся одним из характерных показателей синтеза белка, также обнаруживался в меньшей мере в зараженных тканях. На основании полученных опытных данных о фиксации двуокиси углерода видно, что снижение интенсивности синтеза белков и красящих веществ листа находится в тесной связи с понижением интенсивности фотосинтеза. Интенсивность синтеза органических кислот уменьшается ввиду слишком несоразмерного торможения фиксации в темноте, и можно предполагать, что это препятствует также и дыханию клетки, в случае когда заражение находится в состоянии прогресса.

ОПРЕДЕЛЕНИЕ ЖИЗНЕСПОСОБНОСТИ ПОВРЕЖДЕННЫХ МЕТИЛБРОМИДОМ СЕМЯН ПШЕНИЦЫ С ПОМОЩЬЮ СОЛЕЙ ТЕТРАЗОЛИУМА

Ш. ГАШПАР

Нельзя определить жизнеспособность поврежденных метилбромидом семян пшеницы с помощью ТТС (2,3,5-трифенилтетразолиумхлорид), т. к. и безжизненные зародыши формируют формазант ввиду сильной постмортальной активности их дегидрогеназ. В процессе отложения семена теряют в большей степени жизнеспособность, чем активность дегидрогеназ. При использовании ИНТ (2-(п-йодофенил)-3-(п-нитрофенил)-5-фенилтетразолиумхлорид), вместо ТТС в качестве индикатора мы смогли показать пониженную жизнеспособность семян. Наблюдается сильная корреляция между количеством ИНТ-формазан, синтезированном на сухом веществе, и поглощением кислорода метилбромидом поврежденными зародышами пшеницы. Между количеством формазана ТТС и поглощением кислорода взаимосвязи нет. Ввиду различного поведения ТТС и ИНТ можно думать, что представлявшаяся до сих пор опорная точка на конечной окислительной цепи находится в другом месте, или конечная окислительная система, отличная от цитохромов, играет определенную роль в передаче электрона. Определена линеарная взаимосвязь между количеством ИНТ-формазана, синтезированным на 1 гр сухого вещества поврежденных метилбромидом зародышей и их всхожестью и жизнеспособностью. Нитро ВТ (2,2′ ди-п-нитрофенил-5,5′ дифенил-3,3′-3,3′ диметокс-4,4′ бифенил тетразолиумхлорид) не является подходящим индикатором для определения жизнеспособности зародышей пшеницы.

НОВЫЙ МЕТОД ХИМИЧЕСКОЙ БОРЬБЫ С СОРНЯКАМИ В КРУПНОХОЗЯЙСТВЕННЫХ, ШИРОКОРЯДНЫХ ВИНОГРАДНИКАХ; ОПРЫСКИВАНИЕ ПОЛОС

А. КИШШ

В виноградниках, посаженных широкорядным методом **Lenz Moser** с высокой шпалерой в 1966 г. был заложен опыт по химической борьбе с сорняками с использованием отчасти препаратов отечественного производства, которые можно использовать и в виноградниках, с другой стороны использовались одно или более компонентные химические препараты производства **GEIGY** для борьбы с сорняками винограда. В отличие от традиционных методов, распространение препаратов производилось крупно-хозяйственным способом, применимым в широкорядных насаждениях винограда; к трактору **RS-09 Maulwurf** был присоединен опрыскивающий прибор **S-392**. Практически в течение всего года участок оставался без сорняков.

НОВЫЕ ДАННЫЕ ПО ВНЕСЕНИЮ ОРГАНИЧЕСКОГО УДОБРЕНИЯ НА РАЗЛИЧНУЮ ГЛУБИНУ, НА ПЕСЧАНЫХ ПОЧВАХ

Ф. ХЕПП

Во время закладки опыта песчаную почву одинаково обрабатывали на глубину 50 см, но удобрения вносили на различную глубину. На основании 5-летних опытных данных видно, что в двух случаях внесение органического удобрения на 20 см, а в трех случаях — на 50 см вызвало сигнификантное повышение урожая; в 22 случаях статистически доказать разницу в урожае не удалось.

ПОВЕДЕНИЕ ПРОРАСТАЮЩИХ СЕМЯН *SCIRPUS ARTICULATUS* L.

С. Ц. ДАТТА, А. К. РОИ

Данное исследование показывает, что семена ***Scirpus articulatus*** обладают периодом покоя. У этого вида механизм регуляции прорастания связан с температурой. Свет и химические обработки, повидимому, не оказывают большого влияния на нарушение периода покоя этих семян в отличие от действия переменных температур.

ФОРМИРОВАНИЕ ЭФИРНО-МАСЛИЧНЫХ КАНАЛОВ В РАЗВИВАЮЩЕМСЯ ПЕСТИКЕ *HERACLEUM MANTEGAZZIANUM* SOMM. ET LEV.

А. КОВАЧ — Ш. ШАРКАНЬ

У изученного вида ***Heracleum*** в пестике имеются две различные системы для дифференциации и локализации выделяющегося эфирного масла. Некоторые каналы расположены вблизи от проводящих сосудов и идут в том же направлении, в то время как другие (в стенке пестика имеются свои собственные вместилища эфирного масла) находятся вдали от проводящих сосудов и заканчиваются вглухую. Начальное развитие обоих типов характеризуется неравным делением. Возникновение каналов, сопровождающих проводящие сосуды, совпадает с процессом дифференциации прокамбиальной системы, в то время как возникновение собственных вместилищ эфирно-масличных веществ пестика начинается в различные периоды развития пестика. В стенке завязи уже хорошо можно отличить следующие один за другим зачатки эпителиальных клеток каналов в фазе образования складок при возникновении пестика, в то время как начало дифференциации четырех каналов в перегородке различается только после конца периода образования складок. Вертикальный и горизонтальный рост может быть приписан делению молодых клеток посредством антиклинальных стенок. Вызванное различием ритма и продолжительностью деления количество клеток в эпителиальном слое (в месте среза), в возрасте полного развития, в собственных эфирно-масличных вместилищах пестика будет в 10 раз большим, чем оно было вначале; в то же время в каналах, прилегающих к проводящим сосудам, оно возрастет только в три-четыре раза.

ВЛИЯНИЕ ВРЕМЕНИ И МЕТОДА ПРИМЕНЕНИЯ АЗОТИСТОГО УДОБРЕНИЯ НА УРОЖАЙ КУКУРУЗЫ

И. И'ШО — Т. А. ХУССИЕН

Многими исследователями изучались местод и время внесения азотистого удобрения. Результаты, представленные в данной статье показывают, что метод и время внесения азотистого удобрения влияют на урожай и высоту растений. В оба года опыта, 1965, 1966 раннее применение азотистого удобрения разбрасыванием по всему полю или внесением в рядки перед или сразу после посева сигнификантно влияло на урожай зерна. Опрыскивание листьев азотнокислым аммонием сигнификантно уменьшало урожай зерна в оба экспериментальных года.

ИЗМЕНЕНИЕ АМИНОКИСЛОТ ПРИ ЗАВЯДАНИИ НА СВЕТУ И В ТЕМНОТЕ СРЕЗАННЫХ ЛИСТЬЕВ *SOLANUM LACINIATUM* AIT.

Г. ПАЛФИ

В течение медленного завядания у срезанных листьев были найдены те же аминокислоты, что и у листьев, фиксированных сразу после срезания; однако соотношение аминокислот у первых существенно отклонялось. Это отклонение особенно в отношении амидов кислот, во многом напоминает изменение аминокислот, отмеченное у исследованных больных растений. Однако у завядающих листьев были обнаружены характерные отличные черты, а именно: количество пролина, — по сравнению с контролем, — возросло в 12 раз. Как известно, увеличение содержания пролина обычно наблюдается у растений, страдающих от засухи. Из этого можно заключить, что у срезанных листьев недостаток воды прежде всего выступает как вредный фактор. При этом определении следует заметить, что ассортимент аминокислот завядающих листьев и листьев растений, страдающих от засухи, и в другом отношении имеет много общих черт. У завядающих листьев вместе с пролином увеличилось и количество фенилаланина. В то же время уровень лейцина характерно снизился. Свободный пролин создавался путем синтеза de novo. У образца, листья которого завядали в течение 5 дней в темноте, содержание амонокислот было наибольшим, но в дальнейшие дни, однако, наступало быстрое сокращение и уже в период полного высыхания концентрация аминокислот была наибольшей у образца, который находился на свету.

ВЛИЯНИЕ ДОБАВЛЕНИЯ L-ЛИЗИНА НА РОСТ И ЭФФЕКТИВНОСТЬ ИСПОЛЬЗОВАНИЯ КОРМА РАСТУЩИМИ ЦЫПЛЯТАМИ

АБД ЭЛЬ МЕГИД ДАРВИШ

Изучалось влияние пригодного и наиболее экономичного добавления лизина к корму цыплят породы Венгерский Белый Легкорн в возрасте 21—81 дней. Данные, представленные в этом исследовании, показывают, что 1,20% лизина в корме улучшает рост и превращение пищи цыплят обоих полов в возрасте от 21 до 61 дней. Для цыплят старше 61-дневного возраста повидимому является нежелательным использование 1,20%, т. к. это уменьшает ежедневный прирост в весе и повышает ростовые показатели; наиболее пригодный уровень в течение этого периода (66—81 дней) был 0,90% лизина в корме. Эти результаты показывают, что потребность в лизине у цыплят одного и того же происхождения была выше в ранний период роста цыплят, чем в более поздний, что связано с большей скоростью роста. Не наблюдалось торможения при умеренно-излишнем уровне лизина в течение раннего периода роста (21—61 дн).

ИССЛЕДОВАНИЕ СОДЕРЖАНИЯ СУХОГО ВЕЩЕСТВА ТОМАТА

Л. ВИДЕКИ

Автор исследовал причины сильного ухудшения качества томатов, наблюдавшееся в последние годы, и на основании 7-летих данных стремился найти взаимосвязь между содержанием сухих веществ в различные годы и некоторыми климатическими факторами (температура, осадки). По содержанию сухих веществ в разные годы наблюдались сильные отклонения. Наибольшее отклонение наблюдалось в 1962 г. (8,1%), в то время как в 1965 г. оно составило 5,0% и в 1966 г. — 4,9%. Температурой и осадками периода сбора томатов (июнь, июль, август) как видно нельзя объяснить эту большую разницу, т. к. нет особой связи с температурой, связь с осадками также слабая. Между

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 291—298 (1968)

SOME OBSERVATIONS ON THE FORMATION OF LATERAL ROOTS IN COMMON BEAN (PHASEOLUS VULGARIS L.)

By

P. Gracza

DEPARTMENT OF APPLIED BOTANY AND HISTOGENESIS OF THE L. EÖTVÖS UNIVERSITY, BUDAPEST

In connection with the morphological discussion on germination and detailing the organization of roots the establishment of lateral roots is generally described in the literature as an acropetal process. On the basis of his morphological and histological investigations the author discovered that the first roots of the bean develop — with fairly high frequency — in 2 to 3 levels of origin, toward the cotyledons (basipetally). These roots initiate in the root collar section, where both the simple primary xylem and the continuous transporting tissue system characteristic of the hypocotyl may be found. Subsequently, below the collar level, on the hypocotyl and toward its tip, the organization of the proper acropetally oriented lateral roots begins.

Introduction

An acceptable explanation on the sequence of the origin of lateral roots was first given by Nägeli—Leitgeb (1867). Their establishment, according to which lateral roots rise acropetally from the mother root, refers to the appearance of lateral roots of cryptogams. The lateral roots of phanerogams originate in the same way (cit. Sachs 1870). This establishment was taken over by later issued works, text books (Rees 1896, Velenovsky 1907, Filarszky 1911, Kurszanov *et al.* 1952, Troll 1953, Robbins *et al.* 1965 etc.). Though in some works hints as to the deviation from acropetal organization are found, more detailed examinations in this direction were seemingly not performed (Wettstein 1932, Troll 1953, Guttenberg 1963, Sárkány—Szalai 1966).

Material and Method

The investigations on the formation of lateral roots have been carried out on young seedlings of common bean (*Phaseolus vulgaris* L.). The seeds were germinated at room temperature in Petri dishes and, respectively, in sowing boxes and in the open, using many replications. For examination the seedlings were first collected and examined daily, later every second day. Morphological investigations were conducted with a Cytoplast stereo-microscope and the excisions for histological observations were partly prepared with a razor blade and partly with a microtome from a material embedded into paraffine. The characteristic features chosen were perpetuated in microphotographs.

Results

Morphological investigations. At the beginning of germination, in the first 2 to 3 hours, common bean absorbs an adequate quantity of water, becomes considerably swollen and its size increases to 2—2.5 times as much as the original volume. After the dehiscence of the seed coat the radicle, growing at the beginning intensively, comes — together with the hypocotyl — into the open air. Subsequently it is the hypocotyl that grows more vigorously. In this stage the young primary root and the hypocotyl can clearly be differentiated: the former is a gradually tapering, stake-like, translucent whitish organ primordium proceeding in the upward successively broadening collar of lighter colour, which, again, turns into the somewhat thinner greenish hypocotyl (Fig. 1/A).

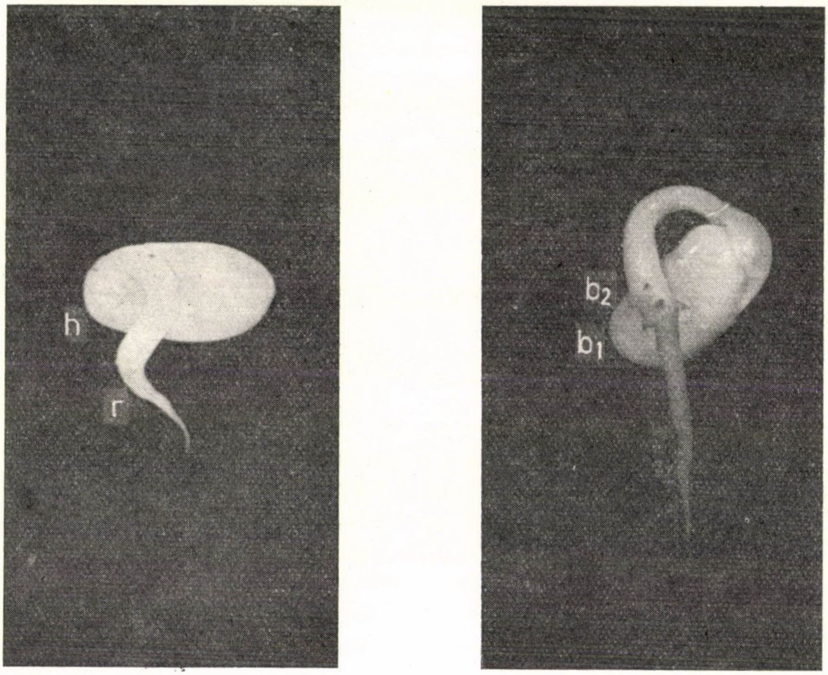
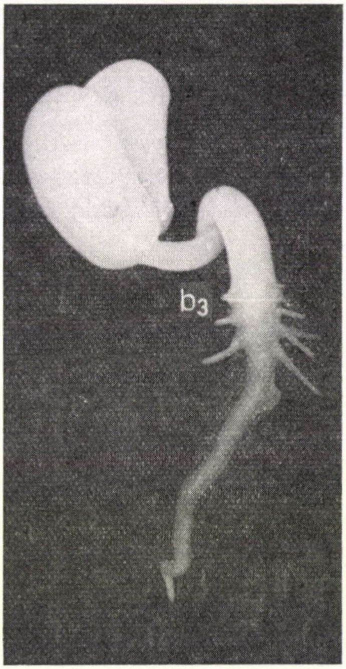


Fig. 1. A) Begin of the germination in bean. r = primary root; h = hypocotyl B) Begin of the lateral root formation. b_1 = first lateral root level; b_2 = basipetally developed lateral root

After the hypocotyl became 15 to 20 mm. long, the further growth of the young primary root accelerates, its length increases from 10 to 20 mm. and on the upper part develops the zone covered with root-hairs.

In this period, i.e. beginning with the second day of germination, in the upper part of the root, on the collar and touching the root-hairy zone at four places, along the median and transversal planes tiny, but gradually increasing bunches appear. After a short while these protuberances dehisce and small lateral roots sprout to the surface, surrounded by a turning up periderm tissue. Somewhat later, along the same orthostichons and in the direction of the cotyledons, on the broadening collar, further bunches, lateral roots develop basipetally (Fig. 1/B). These latter lateral roots are shorter than those formed previously in the lower level. Depending on the variety, in 20 to 90 per cent of young bean seedlings, a further lateral root level of basipetal feature comes into being, exactly on the border of collar and hypocotyl. Accordingly on the young bean seedling 2 to 3 lateral root levels develop basipetally (Fig. 2/A).

Subsequently, (on the 4th to 6th day of germination) in the course of lateral root formation a change takes place. Appearing after those coming into being basipetally, the new lateral roots develop below the level of the



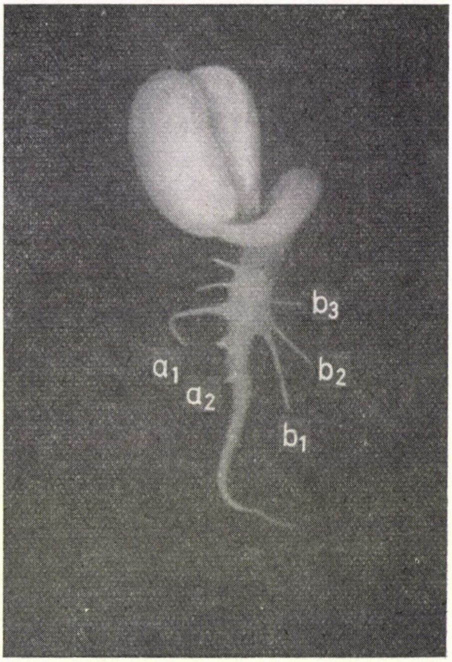


Fig. 2. A) Termination of the basipetally oriented lateral root formation; b_3 = third level of basipetal lateral roots

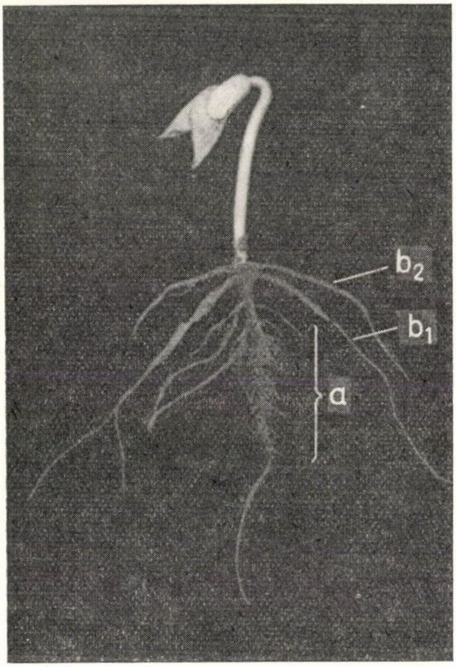
B) Below the basipetal lateral root levels (b_1, b_2, b_3) the acropetally organized lateral roots (a_1, a_2) begin to take shape.

latter, in the direction of the taproot. Succeedingly, younger and gradually shorter lateral roots take already shape with regular acropetal character (Fig. 2/B.).

Lateral roots on 10 to 14-day-old seedlings grow considerably long. Between the sequence of appearance and the length of roots there exists a connection. The oldest roots are the longest, while the younger and upper ones are shorter and of much minor length are in general than the acropetally developed roots (Fig. 3/A).

The early basipetal organization of lateral roots occurs alike in sowing boxes and in the open (Fig. 3/B).

Histological investigations. The young taproot of the bean seedling is 10 to 15 mm. long when the first lateral roots appear on the surface. In this state the undulating cambium has already taken shape, but the transporting tissue system has not yet increased secondarily. The four (in cross-section visible) spindle-like primary xylem fascicles consisting of 5 to 9 elements are divided



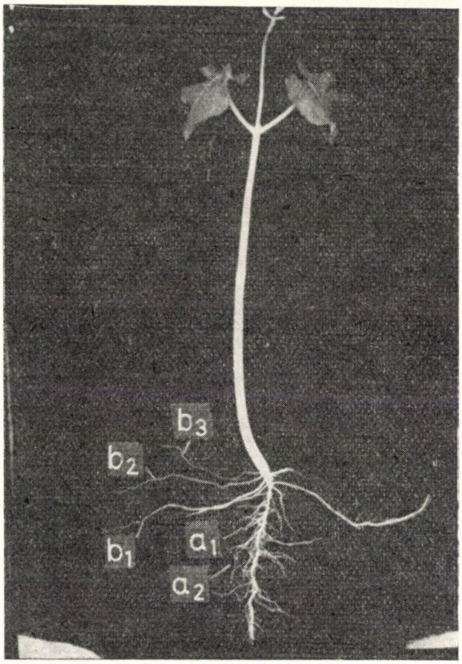


Fig. 3. A) An older seedling germinated in soil; b_1, b_2 = basipetal lateral roots; a = acropetal lateral roots

B) An 18 to 20 day-old seedling with basipetal (b_1, b_2, b_3) and acropetal (a_1, a_2 etc.) lateral roots

by a broad parenchymatic tissue containing shieve tubes, companion cells and phloem parenchyma. The radially elongated cells of pericambium adjoin the smaller Caspary-striped endoderm cells. The broad primary cortex is covered with the root-hairy rhizoderm (Fig. 4/A).

At the border of the taproot and the collar in cross-section a tangential broadening of the simple primary xylem may be observed, while the cells of the pericambium divide in the direction of the primary xylem, i.e. with periclinal walls on four places, and the cell rows coming thus into being and indicating root organization, exert an outward pressure on the cell layer of the endoderm (Fig. 4/B).

The developing small bunches of lateral roots exert a pressure also on the primary cortex, the cells of which drift away from one another giving place to the growing lateral root primordia. The latter, again, grow through the primary cortex, reach and burst the rhizoderm, and appear — as it has already been mentioned — along the median and transversal planes on the surface of the primary root (Fig. 5/A).

Above the level of the first lateral roots, in the characteristic transitional zone, the simple primary xylem broadening continues to run upward, but

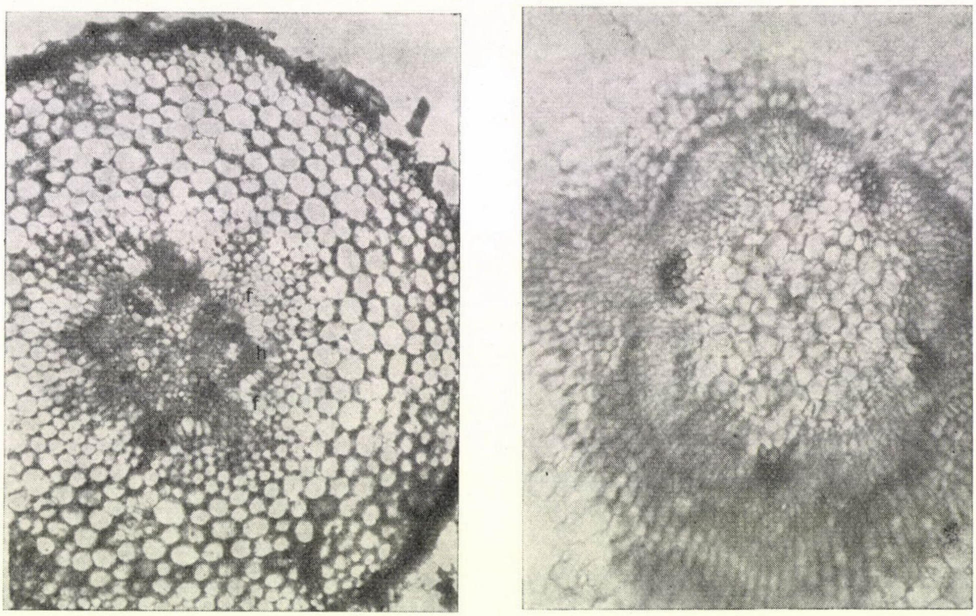


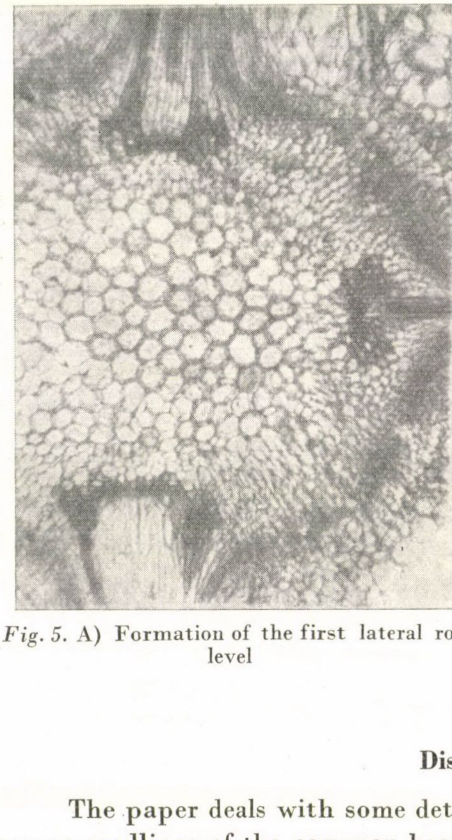
Fig. 4. A) Cross-section of a primary root of the tetrarchstructured bean; *f* = primary xylem; *h* = primary phloem.

B) In the direction of the root collar the primary xylem begins to broaden tangentially.

simultaneously, in cross-section, a continuous transporting tissue system can be observed. This became differentiated from the uniform ringlike procambium, and is already the peculiar tissue region of the hypocotyl, proceeding with a transitional feature in the upper part of the collar. It is built up of isolated, wide-caverned tracheids surrounded by smaller, successively lignifying xylem parenchyma cells. On the external side of the xylem ring small groups of phloem elements take place. On its inner side the primary xylem advancing upward fans out increasingly; the protoxylem elements remain in the middle, the metaxylem elements draw to the sides. On the border of these two kinds of transporting tissue system, in the direction of the primary xylem and above the previous lateral roots, four new lateral roots develop (Fig. 5/B and 6/A).

In most of young seedlings also the third lateral root level comes very soon into being, in the direction of cotyledons. By this time the protoxylem parts of the wing-like opened primary xylem have broken away, and moved off from one another. In this section the continuous transporting tissue system becomes always dominant (Figs. 6/B, C, D).

Subsequently, new lateral roots develop below the level of the basipetally formed ones, with acropetal feature and from the direction of the primary xylem of the taproot.



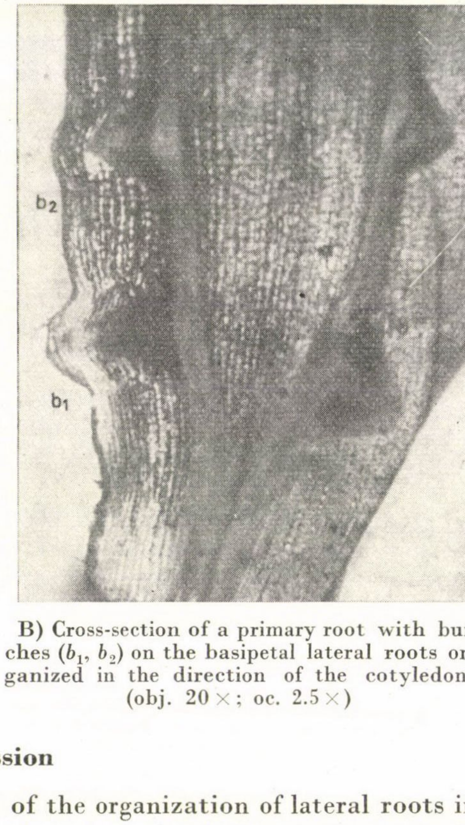


Fig. 5. A) Formation of the first lateral root level B) Cross-section of a primary root with bunches (b_1, b_2) on the basipetal lateral roots organized in the direction of the cotyledons (obj. 20 ×; oc. 2.5 ×)

Discussion

The paper deals with some details of the organization of lateral roots in young seedlings of the common bean *(Phaseolus vulgaris* L.). As an example of the germination and lateral root organization, the development of the bean is often mentioned and the lateral root organization described as an acropetal process. By special literature the morphological and histological investigations reported here prove that in young bean seedlings, after the formation of the first lateral roots the succeeding ones appear in the direction of the cotyledons, exactly in 2 to 3 levels, with so-called basipetal feature. The growth of the acropetally oriented lateral roots in the direction of the taproot tip starts only after the formation of the basipetal lateral roots had been completed.

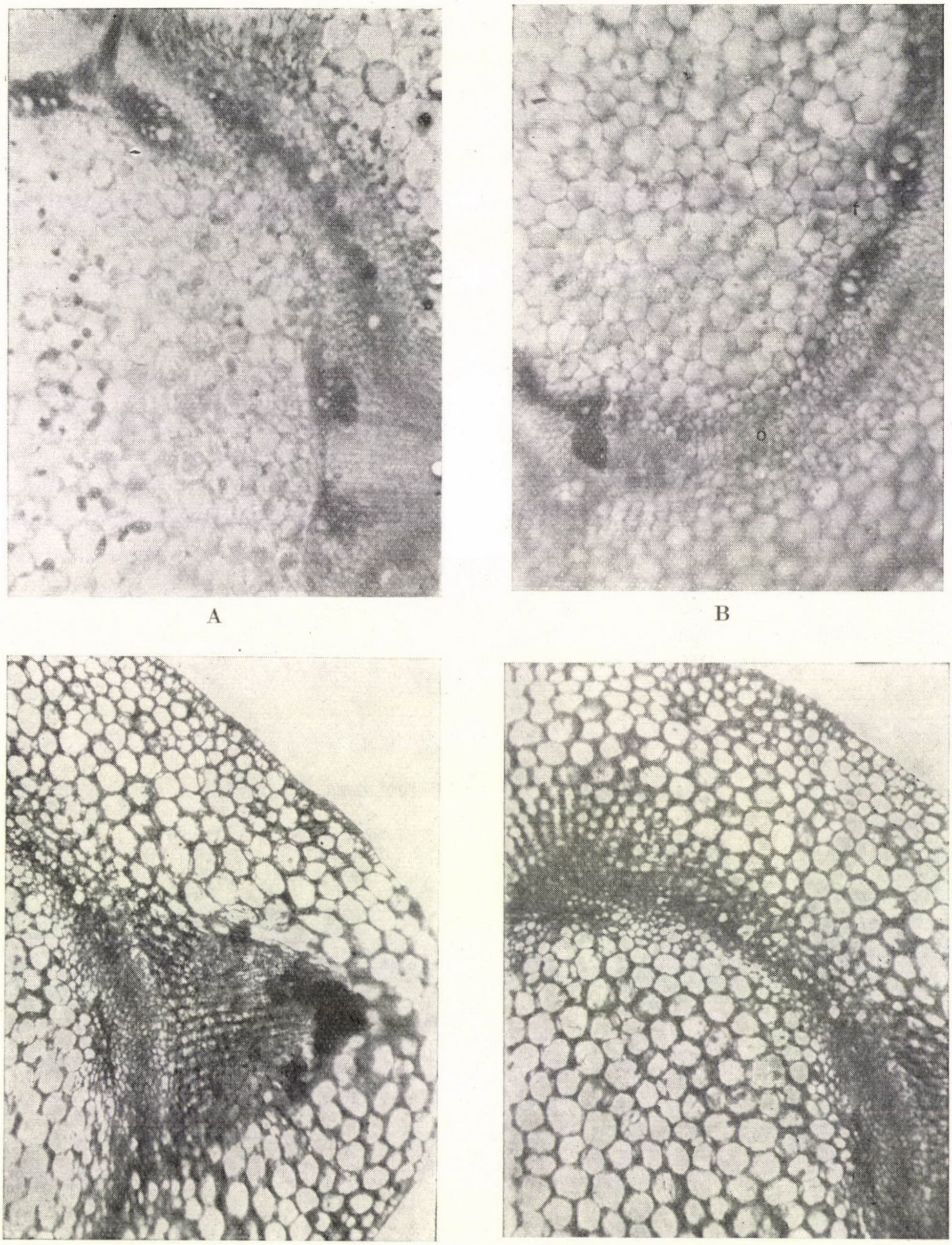


Fig. 6. A) Second developmental level of the basipetally oriented lateral bean roots. B) On the external side of the fanning-out primary xylem the continuous transporting tissue system characteristic of the hypocotyl is clearly visible. *f* = primary xylem; *ö* = continuous transporting tissue system. C) Development of the third (basipetal) lateral root level. D) Cross-section of the hypocotyl (obj. 20 ×; oc. 2.5 ×)

The formation of basipetal lateral roots commences at the upper border of the taproot, proceeds in the collar and terminates at the lower end of the hypocotyl.

According to histological investigations the organization of basipetal roots takes place in the direction of the simple primary xylem. This proceeds into the collar and connected with the continuous transporting tissue system of the hypocotyl it endows, interiorly, too, the morphologically characteristic organ part, the collar, with a transitional character.

The feature of both kinds of lateral roots can be well controlled for a long time even after the development of acropetal lateral roots; the sequence and time of formation is indicated by the length of lateral roots. The pictures of text books (WETTSTEIN 1932, RAUH 1941, TROLL 1953) demonstrate more or less clearly the character of organization, but a description or reference is seldom given; this may perhaps be explained by the lack of more detailed analysis.

The initially basipetal orientation of the lateral root organization occurs both with germination under laboratory conditions (in Petri dishes) and with sowing in the field.

This developmental process of lateral roots may be observed not only in beans but also in other plants, e.g. in ricinus, which will be discussed in a subsequent paper.

REFERENCES

FILARSZKY, N. (1911): Növénymorphologia (Plant Morphology). Budapest.
GUTTENBERG, H. (1963): Lehrbuch der allgemeinen Botanik. Berlin.
KURSZANOV, L. I.—KOMARNYICKIJ, N. A.—MEJER, K. J.—RAZDORSZKIJ, V. F.—URANOV, A. A. (1952): Botanika (Botany). Budapest.
NÄGELI, C. W.—LEITGEB, H. (1867): Entstehung und Wachstum der Wurzeln. — Beitr. zur wissenschaft. Botanik 4. Leipzig.
RAUH, W. (1941): Morphologie der Nutzpflanzen. Leipzig.
REES, M. (1896): Lehrbuch der Botanik. Stuttgart.
ROBBINS, W. W.—WEIER, T. E.—STOCKING, C. R. (1965): Botany. New York—London—Sydney.
SACHS, J. (1870): Lehrbuch der Botanik. Leipzig.
SÁRKÁNY, S.—SZALAI, I. (1966): Növényszervezettani gyakorlatok, Növénytani praktikum (Exercises in Plant Organization, Botanical Practice). Budapest.
TROLL, W. (1953): Praktische Einführung in die Pflanzenmorphologie. I—II. Jena.
VELENOVSKY, J. (1907): Vergleichende Morphologie der Pflanzen. Prag.
WETTSTEIN, R. (1932): Leitfaden der Botanik. Berlin.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 299—302 (1968)

STUDIES ON THE INCIDENCE OF SMUT DISEASE (USTILAGO SCITAMINEA SYD.) OF SUGARCANE (SACCHARUM OFFICINARUM L.) GROWN ON LATERITIC SOIL

By

K. V. B. R. TILAK

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

It was found in general that there was a maximum infection in the month of July—August during the two years of experimentation. This period coincides with the rainy season of this region. This period also corresponds to the initial formation of sugars in the stalks.

Introduction

The incidence of diseases on various crops is often aggravated by soil-climatic conditions and judicious application of manures and fertilizers. Earlier workers (DILLEWIJN 1933, MARTIN 1935) have reported that the increasing nitrogen application promoted the top rot disease in POJ 2878 variety of sugarcane in Java, and eye spot disease in Hawaii. Greater incidence of red rot disease was observed under higher levels of nitrogen fertilization applied as ammonium sulphate and organic manure to sugarcane crop (TILAK 1966). It has also been reported that the application of phosphate and potash offers resistance to eye spot disease and lahira disease of sugarcane (LEE—MARTIN 1928, MOIR 1930). There is a paucity of information on the effect of nitrogen, phosphate and potash on the smut disease of sugarcane under natural field conditions.

Material and Method

Co. 421 variety of sugarcane was grown for two years on a lateritic soil. The soil under present investigation consists of about 0.032 per cent total-nitrogen, 0.005 per cent available P_2O_5, 0.010 per cent available K_2O and 0.195 per cent organic carbon contents respectively. 3^3 confounded factorial design with all possible combinations of 3 nitrogen (0.80 and 160 kg N/ha), 3 phosphate (0.40 and 80 kg P_2O_5/ha) and 3 potash (0.30 and 60 kg K_2O/ha) levels were used. 6 rows (6×6 m) formed a plot. The crop was planted in the middle of February and harvested by the end of January. It was irrigated from the date of planting till the fourth month age of crop at regular intervals and then left on natural precipitation. Nitrogen was applied as top dressing in the form of ammonium sulphate at 40 days intervals from the date of planting. In addition, 30 kg N/ha was applied as organic manure (cowdung containing 0.042 per cent N) 15 days before planting as a common treatment to all the plots. Phosphate and potash were supplied in the form of single superphosphate and potassium sulphate respectively at the time of planting. Apart from the various morphological and biochemical characteristics (results to be published), the smut infection percentage was calculated at monthly intervals from the date of planting by counting the number of infected whips per meter of row.

Results

It was found in general that there was a maximum infection in the month of July—August during both the years. This period coincides with the rainy season of this region. The crop grew well in absence of any soil-moisture stress and also attained its grand growth period. Further, this period also corresponds to the initial formation of sugars in the stalks. Thus, the crop offers

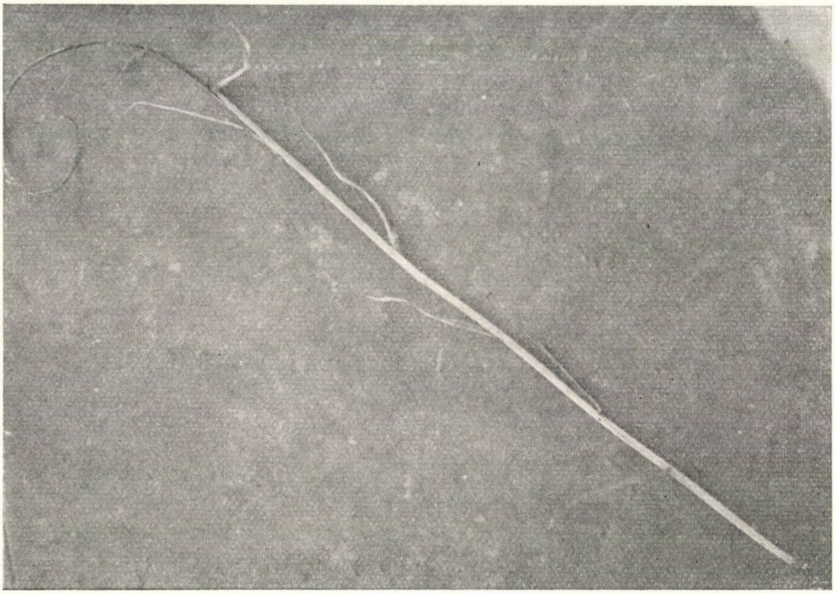


Fig. 1. Smutted whip of sugarcane caused by Ustilago scitaminea Syd.

susceptibility towards the attack of smut fungus. The maximum infection stage under different levels of nitrogen, phosphate and potash during the years 1964—65 and 1965—66 was statistically analyzed (YATES 1937). Table 1 shows that there was a significant increase in smut infection with increase in levels of nitrogen. On the contrary, there was significantly lesser incidence of disease with the increase in levels of phosphate and potash. Application of both the levels of phosphate (40 and 80 kg P_2O_5/ha) and potash (30 and 60 kg K_2O/ha) brought equal amount of control on the incidence of smut disease.

Discussion

Nitrogen at higher levels increases the cell size and decreases the cell wall thickening followed by an increase in vegetative growth (TILAK 1966a). It has been reported by CHONA (1956) that the spores of smut fungus do not

Table 1

Effect of varying levels of nitrogen, phosphate and potash on the incidence of smut disease (Ustilago scitaminea Syd.) on sugarcane

Treatments	Smut infection percentage	
	1964—65	1965—66
Nitrogen:		
0 kg N/ha	3.73	1.42
80 kg N/ha	5.15	3.27
160 kg N/ha	9.26	4.31
S.Em.	$\pm$ 0.3800	$\pm$ 0.2299
C.D. at 5%	1.452	0.6565
C.D. at 1%	3.984	0.9165
Phosphate:		
0 kg P_2O_5/ha	8.84	4.91
40 kg P_2O_5/ha	5.08	1.76
80 kg P_2O_5/ha	4.23	2.33
S.Em.	$\pm$ 0.3800	$\pm$ 0.2299
C.D. at 5%	1.452	0.6565
C.D. at 1%	3.984	0.9165
Potash:		
0 kg K_2O/ha	8.04	4.83
30 kg K_2O/ha	5.21	1.95
60 kg K_2O/ha	4.88	2.23
S.Em.	$\pm$ 0.3800	$\pm$ 0.2299
C.D. at 5%	1.452	0.6565
C.D. at 1%	3.984	0.9165

seem to have a long resting period, but lose their viability after 3 to 4 months. It could be possible that the application of higher levels of nitrogen might bring about all the above changes during that period and might lead to the formation of smutted whips. Application of phosphate and potash thickens the cell wall, changes the reaction and composition of cell sap and serves to offer resistance against smut disease (TILAK 1966b). Further studies on the effect of different soil-climatic conditions and nutritional requirements of the crop in relation to smut infection are in progress.

Acknowledgements

My sincere thanks are due to Prof. Dr. H. K. PANDE, for guidance and to the Council of Scientific and Industrial Research, India, for offering financial assistance which made it possible to complete this work.

REFERENCES

CHONA, B. L. (1956): Presidential address, Pathology Section. Proc. Int. Soc. Sug. Tech., 9th Congress, 975—986.

DILLEWIJN, C. V. (1933): Botany of Sugarcane. The Chronica Botanica Book Co., Waltham, Mass., U.S.A.

LEE, H. A.—MARTIN, J. P. (1928): Effect of Fertilizer Constituents on the Eye Spot Disease of Sugarcane. Ind. and Eng. Chem., **20,** 220—224.

MARTIN, J. P. (1935): Sugarcane Disease Control in Hawaii through the Modification of Agricultural Practices. Proc. Int. Soc. Sug. Tech., **5,** 205—209.

MOIR, W. M. G. (1930): The Plant Food Problem. Repts. Assoc. Haw. Sug. Tech., **9,** 175—203.

TILAK, K. V. B. R. (1966a): Studies on the Growth, Juice Quality, Yield and Incidence of Red Rot Disease on Sugarcane. The Harvester, India (in press).

TILAK, K. V. B. R. (1966b): Studies on the Cultural Practices in the Cultivation of Sugarcane and Upland Paddy Grown on Lateritic Soil. Doctoral thesis, Indian Institute of Technology, Kharagpur, India.

YATES, F. (1937): The Design and Analysis of Factorial Experiments. Imp. Bur. Soil Sci. Horpenden, Tech. Comm., 35.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 303—311 (1968)

RESULTS OF BREEDING LAVANDULA ANGUSTIFOLIA MILL.

By

C. Lőrincz, E. Tyihák

RESEARCH INSTITUTE FOR MEDICINAL PLANTS, BUDAPEST

Classical and modern methods of analysis have been used to examine the clone collection based on morphological characteristics and including *Lavandula angustifolia Mill.* grown in Hungary. On the basis of the results we have been able to select and produce new types richer in volatile oil content and more characterized in the quality of their components.

Introduction

In Hungary lavender is even found growing wild (Augustin 1923) especially in the vicinity of Szentendre. It was probably brought to Hungary during the Turkish rule, in the 16th or 17th century. The first plants of the lavender grown in Hungary today were introduced from France in 1922 and thus began their cultivation on the Tihany Peninsula. The climate and soil conditions of this region proved to be very favourable and in a few years a thriving lavender colony developed.

According to Bittera (1962) the lavender from France was not pure because among the plants in addition to true French lavender *(Lavandula angustifolia* Mill.) a great amount of *L. spica (Lavandula latifolia* Vill.) and many hybrids of the two were found. Pure *Lavandula angustifolia* Mill. plants giving high quality volatile oil were gained after thorough selection.

After World War II lavender breeding was begun in many regions of Hungary in order to produce new strains richer in volatile oil and more select in quality. By doing so the purpose was to improve the quality of the degenerated Tihany stock and to have an appropriate basic plant material for starting new colonies. Such work was carried on at the Horticultural Research Institute and the Agricultural Academy of Keszthely (Csanda 1957) as well as at the Medicinal Plant Research Institute (Bittera 1962, Szathmáry 1961).

Only since 1955 when the growing of volatile oil producing plants was begun on the State Farm of Detailed Daránypuszta (Somogy County) as well as in other regions of the country lavender production has undergone a greater development. In 1965 lavender was produced on almost 1000 cadastral "holds"* (further: c. h.). But the qualitative improvement is not yet on a par with the

* 1 hold = 0.57 ha = 1.42 English acre.

quantitative increase and thus further breeding is required. In this work we try to do our best to take into consideration Hungarian and foreign experiences but think it useful to continue lavender breeding in a new way which has been primarily the result of the modern methods of examination. The following factors have been taken into consideration when developing this new type of lavender breeding.

1. The quality of the volatile oil obtained from lavender inflorescences depends on its components. In spite of this being commonly known it has not up to now been taken into consideration for the breeding work because of the lack of knowledge about modern methods of analysing volatile oil. While trying to satisfy, in lavender breeding, the qualitative requirements considered as yet for one clone (e.g., volatile oil yield, acid number of volatile oil, ester number and percentage, organoleptic characteristics) much inaccuracy and subjective errors have arisen but the possibilities offered by the chemistry for the knowledge of volatile oil components of lavender as well as the new ways of analysis (such as layer and gas chromatography) have been neglected. In our own breeding work not disregarding the requirements of classical methods preference has been given to the modern methods of analysis (TYIHÁK *et al.* 1962). In the chemical analyses done parallel with breeding examination a significant amount of a substance has been isolated from the lavender oil which is the third main component besides linalool and linalilacetate and in this report is included as a "new unknown component" (TYIHÁK *et al.* 1966).

2. We have assigned a great importance to economic factors (flowering time, harvestability, flower yield) c. h. volatile oil yield (c. h.).

3. Since the machine-harvesting of lavender has become important we took this factor into consideration when selecting new clones.

Materials and Methods

a) *Experimental stock.* We used for our initial stock the clone collection of the Darány-puszta State Farm. On the basis of morphological characteristics different types were selected from the *Lavandula angustifolia* Mill. population in 1960/61 and in 1962 93 clones were planted by division. The number of plants per clone was between 38 and 187 with the average being 100 (BITTERA 1962).

This clone collection was studied morphologically during the past three years (1963—65) and the characteristics recorded (plant height, diameter, general habit, position, shape, length and number of peduncles as well as length of inflorescence, its habit, number of cycles and on the two dichasial cyme volutes, the number of inflorescences in the cycles per nodus).

b) *Process of extracting volatile oils.* The inflorescences of certain clones including the peduncles were cut off in full blossom and a portion of the homogenized sample was destemmed and steam-distilled for 3 hours in a five liter copper kettle. The gained volatile oil was separated from the cohobated water and calculated the percentage of volatile oil for the unrefined volatile oil. For the other analyses we dehydrated volatile oil with Na_2SO_4. Volatile oil smeared and remained in the cohobated water was neglected. The remaining major portion of the lavender inflorescences collected from the individual clone plots were put together with the peduncle in a 300 liter copper kettle and subjected to steam distillation. The volatile oil was dehydrated with Na_2SO_4.

c) *Classical methods of examination.* 1. The volatile oil of the individual clones has been organoleptically evaluated (the organoleptical characterization of the volatile oil of the best clones made by a committee of Hungarian experts). 2. The acid number, ester number and percentage (given in linalilacetate) of volatile oils have been determined according to the methods prescribed by Hungarian standards (No. 9251—9252—9253).

d) *Layer chromatographic analysis.* Layer preparation: Desaga layer applicator
Sorbents: Kieselgel G (Merck)
MN Cellulose powder 300 (Macherey-Nagel)
MN Cellulose powder 300 G (Macherey-Nagel)

1. *Layer chromatographic examination of terpene alcohols.* 100—200 γ volatile oil from a petroleum ether solution was dripping for 1 hour onto an at 105° C activated sorbent layer of 250 μ Kieselgel G then chromatographed with benzol ethylacetate in a compound in a ratio of 70 : 40 into a normally saturated large chamber until it reached a height of 18 cm. As a developing reagent concentrated sulphuric acid containing 1% vanilin was used and after spraying the plates were heated at 105° C for 5 minutes.

2. *Layer chromatographic examination of terpene esters.* We were dripping 100—200 γ volatile oil from a petroleum ether solution on an activated sorbent layer of 250 μ Kieselgel G at 105° C for 1 hour then chromatographed it with benzol ethylacetate in a compound with a ratio of 98 : 2 into a normally saturated large chamber until it reached a height of 18 cm. As a developing reagent concentrated sulphuric acid containing 1 per cent vanilin was used and after spraying we heated the plates at 105° C for 5 minutes.

3. *Layer chromatographic analysis of fatty acids with aliphatic short carbon chains in ester bonds (C_1—C_6) and of the released alcohols.* Cca. 70—80 mg volatile oil in 5 ml of peroxide-free ether was dissolved and added 3 ml 5 per cent basic hydroxylamine solution (12 per cent methanolic NaOH and 10% methanolic hydroxlyamine HCl in a compound with a ratio of 1 : 1) then we kept it for 30 minutes in a 25° C thermostat. The solution was then neutralized with 35 per cent HCl or rather made slightly acidic. We dripped 0.01 ml of the filtered solution on the unactivated sorbent layer of the 250 μ thick MN cellulose powder 300 or 300 G, n-butanol-glacial acetic acid and water in a 3.5 : 0.5 : 5 ratio was used as solvent. The solvent-free layer was sprayed with methanol containing 2 per cent $FeCl_3$. The purple colour characteristic of the hydroxamic acids appeared then. We dripped 0.01 ml of the solution containing hydroxamic acid onto a 250 μ thick Kieselgel G layer activated for 1 hour at 105° C and benzol ethylacetate in a proportion of 98 : 2 was used as solvent. In this way we could compare the quantitative relations of the terpene alcohols to these components of the original oil.

4. *Gas chromatographic examination.* The gas chromatographic analysis of the volatile oil of the individual clones has been performed with the following parameters on the Chrom I. analytical flame ionization gas chromatograph:

Column filler	10 per cent Tween-80 (Celite 545)
Length of column	2.55 m
Diam. of column	0.6 cm
Material of column	U-shaped, acid resistant steel tube
Temperature of column	130° C
Gas vehicle	N_2
Speed of circulation	48 ml/min.
Quantity of examined sample	2 μ l
Speed of registry mechanism	10 mm/min.
Sensitivity	1/200

The identifications have been made with the use of standard substances on the basis of measuring relative times of retention. When making the quantitative analyses we measured the areas under the peaks given by the components of the individual volatile oils and these were given in percentage values. In using the method of evaluation we disregarded the deflections of ionizing stream caused by the differences in the structure of the volatile oil components. Thus the percentage proportions used for the quantitative analysis of the volatile oil components of the individual clones are only approximate.

Results

1. While studying the clone collection disposable we unanimously experienced that the clones with light purple inflorescences and light grey leaves

had a lower volatile oil and ester percentage. (Most of the lavender cultures consist of heterogeneous population.) These experiences show a close correspondence to the results achieved so far.

2. The volatile oil yield per c. h. is determined by the volatile oil content in percentage, the number of peduncles in inflorescence and the quantity of inflorescences collected. The number of peduncles has been found especially significant because this shows the greatest fluctuation per type although we have also discovered a great fluctuation in flower yield and volatile oil percentage. These fluctuations can be clearly seen from the data of Tables 1 and 2 where after 3 years study we included the morphological data, the quantitative and qualitative characteristics of the clones appearing to be best out of the 93 ones according to organoleptical tests and present standards. It should also be noted here that from the economical viewpoints (flower yield, volatile oil yield per c. h., position of the plant, its shape, mechanization!) 75 of the 93 clones examined in 1963 were found suitable for further study; in 1964 this number was reduced to 40 and in 1965 to 25.

3. For three years we examined the volatile oil of all 93 clones with layer chromatography in every year. With the layer chromatographic method

Table 1

Morphological characteristics of a few important clones of lavandula angustifolia Mill.

Type no.	Plant		Average habit and position	Peduncle length cm.	Inflorescence	
	height cm.	diam. cm.			length cm.	habitus
8	58	105	Slightly diverging, thick growth, 45°	31	9	long, compact cluster
31	66	117	thick growth, slightly diverging, 35°	32	8	medium, thick
72	65	77	thick growth, rigid, 45°	36	13	long, compact
77	52	79	thick growth, rigid, 30°	25	9	short, compact
80	58	94	thick growth, rigid, 45°	27	11	long, loose
81	59	92	medium growth 25°	26	7	medium long, thin
84	56	110	thick growth, rigid, slightly hanging, 45°	23	9	long, loose
90	61	114	loose, thick growth, 45°	21	9	medium long, compact
92	57	82	thick growth, 45°	34	9	long, compact

suitable for the study of the terpene alcohols and terpene esters as well as on the basis of gas chromatographic analysis of the volatile oils produced in the last year we distinguished the following main types among the clones (Table 3).

Table 2

Data of the important four-year clones of Lavandula angustifolia Mill.

Type no.	No. of flower-bearing peduncle	Percentage distribution of weight flower	peduncle	Yield Flower q/c.h.	Vol. oil. kg/c.h.	Content volatile oil %	Ester %
8	609	46.66	53.34	35.96	15.94	1.00	52.85
31	649	41.66	58.34	43.06	22.31	1.13	40.42
72	437	51.22	48.78	39.64	15.16	0.81	42.35
77	645	54.84	45.16	44.56	18.02	0.85	49.87
80	592	53.57	46.43	29.33	17.42	1.15	50.22
81	364	51.61	48.39	23.33	14.27	2.00	52.85
84	458	50.00	50.00	47.15	30.20	1.22	37.80
90	670	53.49	46.51	—	—	0.83	41.47
92	653	50.00	50.00	17.94	15.68	1.27	54.60

Table 3

Main clone types of Lavandula angustifolia Mill.

Main type	Hydrocarbons	Esters	New unknown compound	Lolool	inather alcohols
1.	+	+	5+	8+	6+
2.	2+	8+	2+	4+	2+
3.	3+	8+	3+	6+	5+
4.	+	10+	3+	3+	6+
5.	+	12+	3+	2+	4+
6.	+	4+	+	10+	6+
7.	+	6+	+	12+	2+

1+ corresponds to a quantity of 1—5 per cent in the volatile oil

From the data of Table 3 as well as from the representative gas chromatogram of Fig. 1 and the layer chromatograms of Figs 2, 3 and 4 it is evident that hydrocarbons, esters (primarily acetate esters), alcohols (primarily linalool) and the new unknown component (the substance appearing between linalool and linalil acetate on the layer chromatograms) form the main components of the volatile oil of *Lavandula angustifolia* Mill.

The number of types is much greater than this because within the individual groups of compounds the share of the individual components in volatile oil can significantly differ both in quality and quantity. As certain free ter-

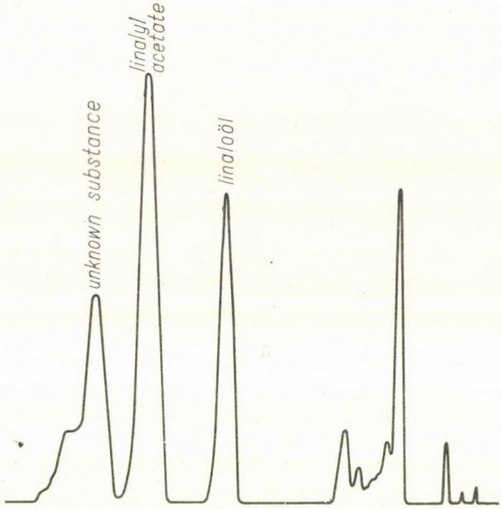


Fig. 1. Representative gas chromatogram of the volatile oil of clones of *Lavandula angustifolia* Mill.

pene alcohols can each give different basic fragrances to volatile oil the main alcohol type (1 and 7) has to be further subdivided, i.e., in addition to the linalool type geraniolic and other types are also possible. The examination of the volatile oil in 93 clones has showed the linalool to be present in all instances though in certain cases it has occurred together with other alcohols in a 1 : 1 ratio.

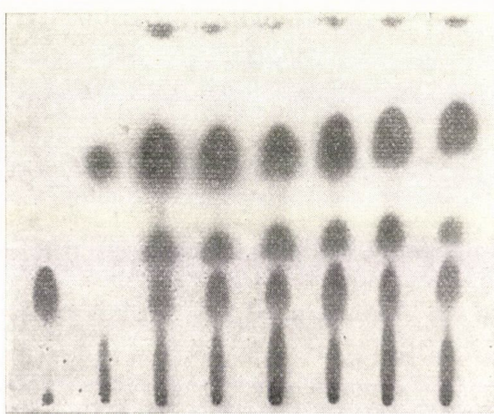


Fig. 2. Layer chromatogram of volatile oils, rich in esters; hydrocarbons; linalyl acetate; unknown; linalool; unknown; type number: 8 31 72 81 80 90

Fig. 2 shows the layer chromatogram of the volatile oil of the best clones; from this it can be clearly seen that in all of them linalil acetate or rather the total esters form a significant part of volatile oils. The study of the distribution of the aliphatic fatty acids with short carbon chains in ester bonds had then been especially necessary possibly by using the hydroxamic acid method. The acetic acid was the main ester component in the examined volatile oils. It was surprising to see that formic acid appeared in all the samples whereas n- and iso-propionic acid as well as n- and iso-butyric acid were found to a lesser extent. The occurrence of n- and iso-valeric acid and capronic acid was sometimes significant. From a practical viewpoint the quantity of fixed

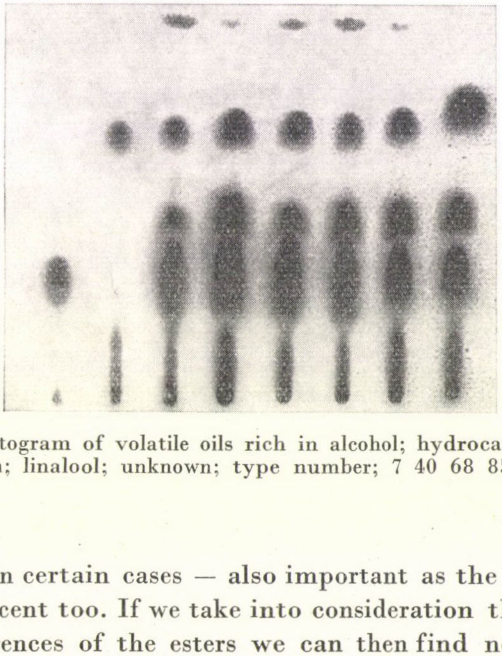


Fig. 3. Layer chromatogram of volatile oils rich in alcohol; hydrocarbons; linalyl acetate; unknown; linalool; unknown; type number; 7 40 68 85 23 55

formic acid is — in certain cases — also important as the total ester content can reach 10 per cent too. If we take into consideration the qualitative and quantitative differences of the esters we can then find newer types worthy of attention. In examining the alcohols released at the time of hydroxamic acid formation we discovered that in addition to linalool other alcohols occurred in ester formation to a greater extent than has been hitherto known in literature. This fact proves the manifold polychemism of lavender which should be better considered in the future breeding work.

Fig. 3 presents the layer chromatogram of volatile oils rich in alcohols. In this case the quantity of esters is not significant. The quantity of the unknown component is relatively high. Here it should be noted that this component is twice as sensitive as linalool or linalil acetate to the vanilin reagent, thus the layer chromatogram presents a distorted picture while the gas chromatogram (Fig. 1) shows a true one.

Figure 4 shows the layer chromatogram of volatile oils presenting a characteristic picture. In cases the quantity of esters or hydrocarbons can be insignificant. From this figure we can also see that the quantity of sesquiterpene alcohols (below linalool) can even approach the quantity of monoterpene alcohols. The practical part of our work relating to lavender breeding shows — which can be clearly seen also from Table 2 — that it has been possible to select clones with a high volatile oil percentage; the volatile oil in each is characterized by high ester percentage. We have yet been unable to decide from

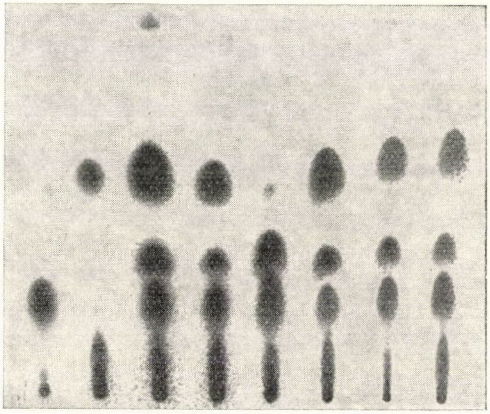


Fig. 4. Layer chromatogram of deviating types of volatile oils; hydrocarbons; linalyl acetate; unknown; linalool; unknown; type number; 10 54 56 76 36 77

the qualitative distribution of the significant ester quantity and from comparing classical characteristics that what ester components, in what quantity cause the pleasant fragrance of lavender volatile oil. The answer requires more years of observation. Otherwise we have found clones whose volatile oils have an equally high ester percentage but have an unpleasant odour. In such cases the qualitative and quantitative distribution of the ester components may deviate from the usual or one of the non-ester components may be present in a larger quantity. Even for this reason it is important to learn more about the non-ester components though in cases industry requires lavender oils with a high alcohol content and by increasing the existing clones the growing demands can be satisfied.

Conclusions

Up to now the qualification of lavender oil has been primarily based on organoleptic criteria and the classical characteristics of quality which contains a good deal of making subjective errors. In trying to produce lavender strains richer in volatile oils and with excellent qualitative characteristics we have united the classical analytical methods with the modern ones. And thus we have been gaining knowledge of the nature of component or components causing the characteristic fragrance of individual volatile oils. Quick, dependable methods are needed as to trace accurately these components.

The present paper containing the first results of our modern lavender breeding work concludes by reiterating that the polychemism of *Lavandula angustifolia* Mill. is manifold. It is the simultaneous occurrence of a significant number of terpene and non-terpene compounds that has to be considered in the volatile oil of each individual plant; their qualitative and quantitative differences, as well as the particular ratio determine the value of volatile oils.

Acknowledgement

Thanks are due to Mme I. Héthelyi, chemical engineer, for doing the gas chromatographic analyses.

REFERENCES

AUGUSTIN, B.—KÁRPÁTI, J. (1923): Herba-Naptár, Budapest, 76.

BITTERA, GY. (1960): Magyarország illóolajos növényei (The Volatile-oil Producing Plants of Hungary). Olaj — Szappan — Kozmetika, Budapest, **3**, 102—107.

BITTERA, GY. (1962): Illóolaj növények termesztési kísérletei (Experiments with the Production of Plants Producing Volatile Oils). Report of the Research Institute for Plant Oil and Household Chemical Industry. Mezőgazdasági és Élelmiszeripari Tudományos Egyesület, Budapest, 94—103.

BITTERA, GY. (1962): Illóolajtartalmú növények nemesítése és kultúrábavétele (Cultivation and Breeding of Plants Containing Volatile Oils). Annual Report of the Gyógynövény Kutató Intézet. Ms, 96—97.

CSANDA, E. (1957): Illóolajos növények nemesítése, agrotechnikája, különös tekintettel a kopárhasznosításra (Breeding and Agrotechnology of Plants Containing Volatile Oils with Special Regard to Usage of Unproductive Soils) Annual Report of the Kertészeti Kutató Intézet, Ms 227—229.

Specification of the Hungarian People's Republic MNOSZ 9251—9252—9253.

GILDEMEISTER, E.—HOFFMANN, FR. (1961): Die ätherischen Öle. VII, Berlin.

GURVICH, N. L.—Гурвич, Н. Л. (1960): Опыт классификации эфиромасличных растений. Растительное сырье. Изд-во АН СССР. Москва—Ленинград, вып. **6**, 7—126.

SZATHMÁRY, G. (1961): Kertészeti Magtermesztés (Horticultural Seed Production). Mezőgazdasági Kiadó, Budapest, 253—258.

TYIHÁK, E.—VÁGUJFALVI, D. (1962): Illóolajok rétegkromatográfiás vizsgálata (Layer Chromatographical Examination of Volatile Oils). Herba Hungarica, **1**, 97—103.

TYIHÁK, E. *et al* (1966): A Magyarországon termesztett Lavandula angustifolia Mill. illóolajának összetételéről (About the Components of the Volatile Oil of Lavandula angustifolia Mill. Grown in Hungary) (in preparation).

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 313—321 (1968)

CHANGES IN THE WEIGHT AND IN THE GERMINATIVE CAPACITY OF WHEAT GRAINS IN THE COURSE OF MATURATION

By

GY. PÁL, M. TALLÉR

AGRICULTURAL RESEARCH INSTITUTE OF THE HUNGARIAN ACADEMY OF SCIENCES, MARTONVÁSÁR

The developmental stuntedness showing itself in acropetal sequence with flowers as well as in the differentiation of the apical and basal spikelet-initiative still remains also in the course of the development of flower and grains. During the maturation of grains and due to divergent variety reactions caused by oecological factors, the intensity of weight increase in grains changes according to varieties. The maximum of the intensity in weight increase is obtained, depending on varieties and climatic factors, at varying times. On the third day reckoned from pollination, the grain of wheat is able for germination, however, full germination (90 per cent) can be experienced with the 15-day-old embryo only.

Introduction

The development in the grain primordium and of the embryo sac inside it as well as the development of the embryo and the grain have been studied by numerous authors. KÖRNICKE (1885) and PERCIVAL (1921) studied the development of the embryo sac, the formation of the ovum, the antipoda, the synergidae as well as that of the two polaris nuclei and the formation of the diploid vegetative nucleus of the embryo sac, respectively. HU (1964) studied the sexual maturity of the eight nuclei in the embryo sac while the way of generative and vegetative nuclei on the occasion of pollination as well as their sequence in the pollen sac were investigated by KIHARA—HORI (1966). The early étapes of the pollination process and the embryogenesis were examined by BLANKOVSKA (1965). The genesis of the sperms that remain outside the embryo sac and the interrelating established with the vegetative tissues of the grain primordium, were investigated by GAVRILOVA (1963), while the importance of large number of pollens in pollination, by ABRAMOVA (1964). The development of embryo and endospermium was studied by IOFFE (1957), the carbonhydrate and protein metabolism occurring in the pistil after pollination by PILNEV—PILNEVA (1963); LIAN-CHZHEN (1963) studied — in case of exterior pollination — the effect of the pollen alien to the variety, exerted on the phosphor-uptake and peroxidase activity of the plant. The grain production decreasing in acropetal sequence at the flowers of spikelets, was studied by RIZHEI (1958) and FAINBRON (1961) established the variability of embryonally young wheat grains. The germination of seeds with different stage of maturity and their biological value established on the basis of the thousand grain-weight, were stated by VIGLÁSI—NAGY (1966); the effect of dormancy in wheat grains on the rate of germination was established by MÁNDY (1963), while the biological importance of the dormancy by POPOV (1966).

Material and Method

The material of our investigations consisted of *Bezostaya 1* and *Fertődi 293* winter wheat varieties originated from a crop sown by machine at the usual time.

A) Establishing the increase of weight in the grains during maturation. From the ears of both varieties apical and basal spikelets had been removed in a way that in one ear there remained only 20 spikelets. The flowers in the spikelets were isolated and the time of maximum flowering was considered as the time of pollination. From the time of pollination ears were gathered every third day, the developed grains removed, then the weight and increase in weight, respectively, were established individually with torsion balance.

B) *The germination of wheat grains of various maturation.* The wheat grains lifted from the ears had been made to germinate without allowing them to be dormant. Germination was performed in three repetitions, in Petri-dish, on wet filter-paper in a thermostat of 25° C. The rate of germination was established daily, always in the same part of the day.

In the course of our investigations we wanted to establish the following:

1) The rate of weight increase in the course of maturation.

2) How many days after pollination are required for the embryo to become able for germination.

Results

1) *Weight increase in the wheat grains during the maturation of grains.* The weight increase of the grains depends on the position of spikelets in the ear as well as on that of the grain in the spikelet, — i.e. in which spikelet of the ear and in which flower of the spikelet it has developed.

a) *Weight increase of the total number of grains in the ear.* It has been established how the weight of the total number of grains in the ear and the weight of grain per ear developed in the course of maturation. The results of our investigations are shown in Table 1. From the data of Table 1 it can be seen that during the development of the grain the rate of weight increase in the variety *Fertődi 293* was quicker than in the variety *Bezostaya 1.*

b) *Weight increase per every three days in the sequence of spikelets.* In the two varieties examined the weight increase per spikelethas also been established, viz., the weight increase of the total number of grains in the spikelet; this is shown in Tables 2 and 3. From the data of both Tables it can be conclud-ed that the rate of weight increase is the highest in the two-third parts of the ear towards the apex while in the basal and apical part the increase of weight is the quickest.

c) *Weight increase per every three days in the sequence of flowers.* During the development of grains in the spikelets of winter varieties *Bezostaya 1* and *Fertődi 293* the increase of grain weight has been established in acropetal sequence, and the results obtained are shown in Tables 4 and 5. From the data

Table 1

Weight increase of the total number of wheat grains in the ear

Number of days from pollination	*Bezostaya 1*	*Fertődi 293*
	Change in the weight of grains/ear	
3	21.6	18.0
6	61.6	85.8
9	83.0	141.2
12	243.6	201.4
15	296.4	457.8
18	496.8	582.6
21	688.4	1016.0
24	825.8	1394.0
27	1669.8	1910.0

Table 2

Weight increase of the wheat grains in the sequence of the spikelets during grain development Bezostaya 1

Number of spike-lets	Number of days from pollination								
	3.	6.	9.	12.	15.	18.	21.	24.	27.
1.	—	—	—	2.0	—	9.5	8.0	22.0	66.6
2.	—	1.0	1.0	8.0	7.0	17.0	29.6	36.0	102.4
3.	2.0	3.0	4.0	11.2	13.8	35.0	42.4	60.3	117.6
4.	2.3	3.0	4.4	17.8	17.0	39.4	35.8	61.0	107.2
5.	2.5	3.2	5.7	11.8	13.8	42.4	45.0	63.0	127.4
6.	3.6	5.0	6.5	11.8	18.2	30.2	45.4	65.8	117.6
7.	3.4	4.7	7.0	21.4	17.2	41.0	53.4	79.8	136.4
8.	3.6	4.8	7.0	23.2	33.0	48.0	62.0	80.2	113.0
9.	3.8	5.7	6.8	21.4	19.4	42.6	56.0	69.0	119.6
10.	3.0	6.4	7.8	16.0	23.6	34.6	50.2	63 3	129.4
11.	2.4	5.8	7.6	18.4	24.6	38.4	55.0	61.2	105.0
12.	1.8	4.2	6.8	17.2	23.6	34.0	47.8	56.8	119.2
13.	1.8	3.6	6.4	15.2	23.0	28.8	43.8	38.2	80.8
14.	1.0	2.6	5.6	13.4	18.0	21.6	38.4	43.8	72.2
15.	2.0	2.2	4.8	13.8	16.4	19.0	33.0	39.0	82.7
16.	1.5	1.5	3.2	7.4	12.8	13.6	22.6	26.3	63.0
17.	—	1.0	2.4	6.0	10.0	13.0	24.0	28.0	40.3
18.	—	1.0	1.2	3.8	8.2	9.5	14.5	20.0	32.7
19.	—	—	1.0	2.8	6.2	6.0	15.0	17.6	32.0
20.	—	—	1.0	1.1	5.6	6.0	7.5	13.0	28.0

of the Tables it seems to be proved that the increase of weight in three days period was considerable with both varieties. The weight and weight increase of the grain, developing from the main flowers of the spikelet (1st and 2nd flower) reveal no significant difference. On the other hand, the weight and the weight increase of the grains developing from the main and secondary flowers, do show a significant difference to the advantage of grains that have developed from the main flowers. (Grains out of the 3rd and following flowers). The weight increase of the grains developing from the secondary flowers is of a quicker rate than those developing from the 1st and 2nd flowers.

d) *Formation of weight differences per every third day.* During maturation, between the two dates examined weight differences have also been established in order to know whether it was at the beginning or at the end that the rate of weight increase was greater. The results are shown in Table 6 expressed in mg and also in percentage, i.e. to what percentage of the previous value has

Table 3

Weight increase of the wheat grains in the sequence of the spikelets during grain development
Fertődi 293

Number of spike-lets	Number of days from pollination								
	3.	6.	9.	12.	15.	18.	21.	24.	27.
1.	—	—	—	—	—	—	—	—	72.0
2.	—	1.0	3.0	4.0	—	18.0	31.0	—	76.2
3.	—	2.6	6.2	9.5	20.6	23.8	46.2	79.4	113.0
4.	—	4.2	7.6	8.8	27.8	35.8	52.0	88.4	137.0
5.	2.0	4.8	10.4	15.8	34.6	39.0	80.2	117.2	158.6
6.	1.5	5.8	11.2	17.0	36.4	44.6	69.0	97.2	137.6
7.	1.6	7.2	12.2	18.6	37.0	58.0	84.6	120.1	144.4
8.	2.2	6.6	13.0	17.0	41.0	48.0	85.0	97.0	150.4
9.	2.0	7.6	12.0	18.8	37.2	47.4	84.2	120.4	143.4
10.	2.6	8.4	12.4	15.2	36.4	48.4	74.4	95.6	142.4
11.	1.8	7.6	10.0	17.2	32.6	36.6	74.0	93.6	122.0
12.	1.8	7.0	10.0	15.2	30.0	42.0	62.4	76.6	115.6
13.	1.2	5.0	7.6	13.2	24.2	31.2	55.2	78.0	97.0
14.	1.4	5.4	8.6	10.6	23.0	32.4	55.2	76.0	93.4
15.	1.0	4.6	6.4	7.8	23.0	28.6	46.2	64.6	71.8
16.	1.0	3.2	5.4	8.0	19.4	24.2	42.4	61.2	71.6
17	1.0	2.4	3.4	5.4	15.6	20.2	36.4	47.0	56.6
18.	—	1.6	2.2	5.3	6.5	14.5	29.4	36.7	37.0
19.	—	1.6	2.2	3.7	8.5	13.0	22.0	24.0	30.2
20.	—	2.0	—	2.5	8.0	13.0	17.3	22.2	31.0

Table 4

Weight increase of the wheat grains in the sequence of the flowers, during the development of the grain

Bezostaya 1

Number of days from pollination	Weight of wheat grains in the flowers of the spikelets in the ear, mg					
	flower 1		flower 2		flower 3	
	x	s	x	s	x	s
3.	1.83	1.03	1.87	1.19	—	—
6.	2.51	0.98	2.16	0.99	—	—
9.	3.20	0.94	3.19	1.29	1.00	0.00
12.	7.45	2.83	7.22	2.31	3.05	1.48
15.	10.22	2.45	10.06	5.44	7.11	2.03
18.	15.88	4.60	16.09	4.49	9.06	3.90
21.	22.04	7.12	21.63	7.39	14.28	5.30
24.	31.41	2.35	31.12	8.61	19.75	3.20
27.	48.67	3.38	44.11	1.86	44.73	2.18

Table 5

Weight increase of the wheat grains in the sequence of the flowers, during the development of the grain

Fertődi 293

Number of days from pollination	Weight of wheat grains in the flowers of spikelets in the ear, mg					
	flower 1		flower 2		flower 3	
	x	s	x	s	x	s
3.	1.20	0.40	1.03	0.02	—	—
6.	2.93	1.08	2.45	0.10	1.31	0.10
9.	4.43	1.73	3.61	1.21	2.11	0.73
12.	6.56	2.21	5.61	1.83	3.58	1.21
15.	12.59	2.31	11.89	3.26	9.13	1.51
18.	17.89	3.09	17.77	3.30	13.07	3.39
21.	26.23	4.32	26.03	5.20	20.84	5.17
24.	37.12	10.54	37.84	8.69	31.75	6.60
27.	47.08	8.48	43.84	9.04	38.95	4.88

the subsequent one increased. From Table 6 it becomes evident that with both varieties the weight differences increase during maturity. In the case of *Bezostaya 1* weight differences are being formed according to a gradual increasing, while in the case of *Fertődi 293*, according to an optimum curve. Weight difference and weight increase, respectively, show the maximum between 9—12 days with *Bezostaya 1*, and between 12—15 days in the case of *Fertődi 293*.

Table 6

Increase of weight in the wheat grains (Weight-differences measured

Number of days from pollination	Bezostaya 1 — Weight increase in the flowers of spikelets in the ear every 3 days					
	flower 1		flower 2		flower 3	
	mg	%	mg	%	mg	%
0—3	1.83	—	1.87	—		
3—6	0.68	137.15	0.29	115.50		
6—9	0.69	127.49	1.03	147.68	1.00	—
9—12	4.25	232.81	4.03	226.33	2.05	305.00
12—15	2.77	137.18	2.84	139.33	4.06	233.11
15—18	5.66	155.38	6.03	159.94	1.95	127.42
18—21	6.16	138.79	5.54	134.43	5.22	157.61
21—24	9.37	142.51	9.49	143.87	5.47	138.30
24—27	17.26	154.95	12.99	141.74	24.98	226.48

2) The germination of wheat grains of various maturation levels. Air-dry wheat grains have been made to germinate without dormancy. The rate of their germinating capacity and the length of their germination time have been examined.

a) *Germinating ability of wheat grains of various maturation.* The percentage of germinated wheat grains as compared to the total number of wheat grains caused to germinate, has been stated, and is shown in Table 7. From the data of Table 7 it can be seen that, in case of both varieties, as early as on the

Table 7

Germinating capacity of wheat grains of different maturation

Number of days from pollination	*Bezostaya 1*	*Fertődi 293*
	percentage of germination	
3	2.47	0.00
6	1.90	14.77
9	17,02	48,97
12	53.33	87.65
15	94.11	94.18
18	98.59	100.00
21	93.50	98.85
24	100.00	97.50
27	97.53	97.95

every third day, in mg and in percentage)

Number of days from pollination	Fertődi 293					
	Weight increase in the flowers of spikelets in the ear every 3 days					
	flower 1		flower 2		flower 3	
	mg	%	mg	%	mg	%
0—3	1.20	—	1.03	—		
3—6	1.42	244.16	1.42	237.86	1.31	—
6—9	1.16	151.19	1.16	147.37	0.80	161.06
9—12	2.00	148.08	2.00	155.40	1.47	169.66
12—15	6.28	191.92	6.28	211.94	5.55	255.02
15—18	5.88	142.09	5.88	149.45	3.94	143.15
18—21	8.26	146.61	8.26	146.48	7.77	159.44
21—24	11.81	141.51	11.81	145.37	10.91	152.35
24—27	11.00	126.83	11.00	129.06	7.20	122.67

third day after pollination, the wheat grains harvested are able to germinate and, to a small extent, they do germinate, however, full germination (90 per cent) could be obtained with those harvested on the 15th day after germination.

b) *Phase of germination with wheat grains of different maturation level.* With both wheat varieties the phase of germination has been established without allowing them a state of being dormant. The results are shown in Table 8.

Table 8

Phase of germination in wheat grains of different maturity

Number of days from pollination	Bezostaya 1		Fertődi 293	
	phase of germination, in days			
	x	s	x	s
3	3.67	0.55	0.00	0.00
6	11.00	0.00	5.00	5.26
9	11.81	7.41	3.19	0.93
12	3.86	2.86	2.38	0.74
15	3.91	3.73	3.37	2.50
18	2.07	0.40	2.23	1.81
21	2.61	1.57	2.09	1.26
24	2.14	0.41	2.29	0.71
27	2.08	0.24	2.00	0.00

If the time that has elapsed reckoned from fertilization, is short, viz., in the case of early harvest, the time of germination grows longer, in other words: germination is prolonged. This is greater with *Bezostaya 1* than with *Fertődi 293*.

Conclusions

The quicker rate of weight increase observed in the course of grain development in the variety *Fertődi 293* as compared with *Bezostaya 1*, is a varietal property or — under the given weather conditions — the nutritive matter might be accumulated quicker in the grains of the variety *Fertődi 293* than in those of *Bezostaya 1*, thus, it is the result of the effect of environmental factors.

The flowers as well as the apical and basal spikelets display — in acropetal sequence — a developmental stuntedness that shows itself as early as the differentiation of the spikelet — and flower primordia, — and it still remains also during the development of flower and grains. The weight increase that occurs only later with the apical and basal flowers, leads to the conclusion that the spikelets and flowers supplied with nutriment in an uneven way are responsible for their stuntedness which will, however, be balanced during maturation.

The weight difference maximum that can be experienced between the 9—12 days in the case of *Bezostaya*, and the 12—15 days with *Fertődi 293*, might be the date and the result, respectively, of the beginning of considerable deposition of storage-starch. According to IOFFE (1957) starch can be detected in the grain of wheat on the 8—9th days after pollination and it is when the considerable and quick deposition of same gets started.

After the 3rd day of pollination, under the germination conditions examined by the authors, the grain of wheat is able to germinate. That fact agrees with the conception supposed by them, viz., by improving the conditions of germination (temperature, moisture content, supply of nutriments, pH, etc.), this latter can be brought even to an earlier date (cp. embryo breeding). Therefore, the problem concerning the day after the pollination, when the embryo becomes ready to germinate, depends not so much on the time that has elapsed since fertilization, but primarily on the conditions of germination.

Due to the shortness of time after pollination, when causing the early harvested wheat grains to germinate, the process of maturation comes to an end in the grains and that process prolongs the phase of germination. On the occasion of water uptake the maturation is being completed first and the process of germination starts only after that. This might be the cause due to which the germination phase of early harvested wheat grains becomes longer.

Acknowledgement

Authors want to express their thanks to dr. Erna Rajki, senior research member, for rendering it possible to achieve their experiments, for supporting their work by furnishing them with useful advice.

REFERENCES

Abramova, Z. V. — Абрамова, З. В. (1964): Цитоэмбриологическое изучение избирательности в оплодотворении пшеницы. Агробиология, **4,** 544—549.

Blankovska, T. R. — Бланковска, Т. Р. (1965): Цитоэмбриологичне дослидження пшеницы пры мижвыдовому скрещувани. Укр. бот. журн. **22,** 36—39.

Fainbron, B. D. — Файнброн, Б. Д. (1961): Об изменчивости пшеницы при посеве эмбрионально молодых семян. Докл. ТСХА. Биол. и растениеводство, **62,** 119—124.

Gavrilova, O. M. — Гаврилова, О. М. (1963): Некоторые особенности генезиса спермиев в тканях завязи пшеницы. Тр. инст. ген. АН СССР, **30,** 291—300.

Hu, S. Y. (1964): Morphological and Cytological Observations on the Process of Fertilization of the Wheat. Sci. Sin. **13,** 925—936.

Ioffe, M. D. — Йоффе, М. Д. (1957): Развитие зародыша и эндосперма у пшеницы, конских бобов и редиса. Морфология и анатомия растений. Изд-во АН СССР, **4,** 211—269.

Kihara, H.—Hori, T. (1966): The Behavior of Nuclei in Germinating Pollen Grains of Wheat, Rice and Maize. Züchter, **36,** 145—150.

Körnicke, F.—Werner, H. (1885): Handbuch des Getreidebaues. II. Parey, Berlin, 1009.

Van, Lian-Chzhen — Ван Лян-Чжен. (1963): Влияние опыления разной пыльцой на поглощение фосфора яровой пшеницей Докл. ТСХА. Биол., земл. и растениеводство, Москва, **83,** 55—59.

Mándy, Gy.: (1963): A búza csírázása. (The germination of Wheat). In: Lelley, J.—Mándy Gy.: A Búza (The Wheat) 108—115.

Percival, J. (1921): The Wheat Plant. Duckworth Co. London, 473.

Popov, A. V. — Попов, А. В. (1966): Биологическое значение покоя (затрудненного прорастания) семян. Ж. общ. биол. **27,** 544—554.

Pilnev, V. M.—Pilneva, P. N. — Пыльнев, В. М. — Пыльнева, П. Н. (1963): Углеводно-белковый обмен в пестике пшеницы при опылении пыльцой разных сортов. Докл. ТСХА. Биол. земл. и растениеводство. Москва, **88,** 251—256.

Rizhei, I. R. — Рыжей, И. Р. (1958): Продуктивность цветков колоса пшеницы в зависимости от времени цветения. Докл. ВАСХНИЛ, Москва, **1,** 8—10.

Viglási, P.—Nagy, B. (1967): Investigation of the Biological Value of Winter Wheat Seeds Harvested at Various Dates. Acta Agronomica Acad. Sci. Hung. **16,** 189—196.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 323—327 (1968)

NITROGEN FIXATION BY CALOTHRIX SP. AS INFLUENCED BY CERTAIN SODIUM SALTS AND NITROGENOUS COMPOUNDS

By

A. S. El-Nawawy, A. N. Ibrahim, M. Aboul-Fadl

DEPARTMENT OF MICROBIOLOGY, MINISTRY OF AGRICULTURE; DEPARTMENT OF MICROBIOLOGY, FACULTY OF AGRICULTURE, ALAZHAR UNIVERSITY, CAIRO

Nitrogen fixation by a local strain of blue-green alga, *Calothrix* sp. has been studied in the laboratory. Growth of the alga was inhibited by Na_2S at the rate of 3180 p.p.m. but not affected by NaCl at concentrations of 795 and 1590 p.p.m.; but severely depressed at 3393.5 p.p.m. of NaCl. The fixation was 50 per cent reduced in the presence of 21 mg nitrogen per litre in form of ammonium sulphate, and asparagine, and completely checked at 105 mg. On the light of the results nitrogen fixation in paddy fields was discussed.

Introduction

The importance of atmospheric nitrogen fixation in paddy soils by certain species of blue-green algae was proved by several authors (Watanabe *et al.* 1951, Watanabe 1962, Allen 1956, El-Nawawy *et al.* 1958 and Aboul-Fadl *et al.* 1965).

In U. A. R., field experiments showed that inoculation of soil with *Tolypothrix tenius* had, generally, benificial effect upon rice yield. Attempts were made to isolate some local isolates of blue-green algae from rice fields in different localities. Four pure isolates were obtained with the aid of some chemicals (El-Nawawy *et al.* 1962). One of them, identified as *Calothrix* sp.* was most effective in nitrogen fixation.

The present work is a study of some factors, e.g., sodium chloride, sodium sulphide, and some nitrogenous compounds on the activity of that type of algae when introduced into the soil.

Materials and Methods

Materials. 1. *The inoculum:* The inoculum was prepared by propagating the alga *Calothrix* sp. in 150 ml. conical flasks containing 30 ml. of sterilized nitrogen-free medium (Watanabe 1951). 2. *Sodium salts:* Separate solutions of sodium chloride (25.4 g./L.) and sodium sulphide (24.0 g./L.) were prepared. 3. *Nitrogenous compounds:* Ammonium sulphate, potassium nitrate and asparagine were chosen for this test.

Methods. The experiments were carried out in 250 ml. conical flasks containing 30 ml. of the nitrogen-free medium. The flasks were treated as follows:

* This alga was isolated from fertile Egyptian soils and identified by Dr. Abdel-Halim Nasr, The Dean of Faculty of Science and Head of Botany Department, Alexandria University.

1. Sodium chloride experiment: The original solution was added to satisfy the following concentrations of NaCl: 0, 424.2, 873.8, 1747.5, 3393.5 and 4191.0 p.p.m. Then the flasks were autoclaved for 15 minutes at 15 P.s.i.

2. Sodium sulphide experiment: The original solution was sterilized by Seitz filter, then added to a set of sterilized flasks to satisfy the following concentrations of sodium sulphide: 0, 795, 1590, 3180, 6720, and 8310 p.p.m.

3. Nitrogenous compounds experiment: Ammonium sulphate, potassium nitrate and asparagine were added to satisfy the following concentrations of nitrogen: 0, 21 and 105 p.p.m., and the flasks were then sterilized.

The flasks were inoculated with a loopful of algal inoculum and kept under direct and indirect sunlight at 25—50° C. After 8 weeks, the algal growth was filtered, weighed, and its nitrogen content was determined by the Kjeldhal method. Soluble nitrogen was determined in the filtrate according to JACKSON (1958).

Results

The results obtained from the different treatments are given in Tables 1, 2 and 3. The nitrogen fixed from atmosphere was calculated as follows: nitrogen content of algal growth + soluble nitrogen in the filtrate — nitrogen added to the medium.

Table 1

Effect of sodium chloride on the growth of Calothrix sp. and its ability of nitrogen fixation

Treatments	Algal dry wt.	Total N in alga		Soluble N in filtrate	Fixed N	
Na Cl p.p.m.	g./L.	%	mg.	mg./L.	mg./L.	Relative figures. Control is considered as 100
Control	3.432	2.83	97	14	111	100
424.2	3.498	2.82	99	10	109	98
873.8	3.102	3.30	102	10	112	101
1747.5	3.234	3.08	100	7	107	96
3393.5	2.871	2.08	60	10	70	63
4191.0	3.069	1.90	58	10	68	61

From Table 1, it could be deduced that the growth of the alga (in terms of dry weights) was reduced in the presence of 873.8 p.p.m. of NaCl; but the ability of its nitrogen fixation was almost not reduced at the first three concentrations of sodium chloride (below 3393.5 p.p.m.).

Table 2 shows that the maximum concentration of sodium sulphide at which the growth of alga could occur is 1590 p.p.m., and the higher concentrations do not admit any growth. It could be pointed out, however, that the concentration 1590 p.p.m. the alga did not lose its ability for growth, only its ability for nitrogen fixation was considerably decreased. This is evidenced by the results which show that in the absence of sodium sulphide the total nitrogen fixed reached to 111 mg. per litre of the medium, while it reached to 45 mg. per litre only in the presence of the salt.

Table 2

Effect of sodium sulphide on the growth of Calothrix sp. and its ability of nitrogen fixation

Treatments	Algal dry wt.	Total N in alga		Soluble N in filtrate	Fixed N	
Na Cl p.p.m.	g./L.	%	mg.	mg./L.	mg./L.	Relative figures. Control is considered as 100
Control	3.432	2.83	97	14	111	100
795	3.330	2.10	70	11	81	73
1590	2.475	1.52	38	7	45	41
3180	—	—	—	—	—	—
6720	—	—	—	—	—	—
8310	—	—	—	—	—	—

Table 3

Effect of nitrogenous compounds on the growth of Calothrix sp. and its ability of nitrogen fixation

Nitrogenous compounds			Algal dry Wt.	Total N in alga		Soluble N in filtrate	Fixed N	
Compound/L.		G;N./L.	g./L.	%	mg.	mg./L.	mg./L.	Relative figures. control is considered as 100
Ammonium sulphate	0.2	21	2.5	2.72	68	6	53	52
	1.0	105	2.0	2.60	52	55	2	2
Potassium nitrate	0.3	21	2.9	2.80	81	11	71	70
	1.5	105	2.8	2.80	78	87	60	59
Asparagine	0.2	21	2.9	2.70	78	9	66	65
	1.0	105	3.0	2.80	84	41	20	20
Control			3.2	2.90	93	10	102	100

It appears from the data recorded in this table that the atmospheric nitrogen fixation was appreciably reduced by all types of nitrogen compounds present in the medium; the reduction was pronounced in the presence of the higher concentration (105 mg./L.) of ammoniacal and organic nitrogen. It is to be noted that no determination was made for any probably organic nitrogen in the filtrate; so, one should be cautious in interpreting such results.

Discussion

Rice is cultivated in the northern regions of the Nile Delta where soils contain about 3000 to 6000 ppm. total soluble salts including about 1800 to 2400 NaCl. From the present work it became clear that the ability of alga, *Calothrix* sp. to fix atmospheric nitrogen was slightly affected by 1747.5 p.p.m.

of NaCl and severely affected in the presence of 3393.5. Its growth was not affected appreciably till the highest concentration was used (4191 p.p.m.). ALLEN (1956) found that the growth of *Anabaena cylindrica* was normal in the presence of 1500 p.p.m. of NaCl but growth took place after a long lag in 20,000 p.p.m. salt.

Rice spends most of its life under water-logged conditions, and this may lead to the formation of H_2S and sulphides through sulphate reduction by some soil microorganisms. STURGIS (1957), and ABD-EL-MALEK — RIZK (1963) found in their laboratory works that, under certain conditions, the percentage of sodium sulphide may reach to 780 p.p.m. in water-logged clay soil. This work showed that the concentration of 3180 p.p.m. Na_2S inhibited the algal growth, while the two lower concentrations 795 and 1590 p.p.m. were harmful for both growth and nitrogen fixation.

Hence, it is likely that *Calothrix* sp. would not suffer under field conditions due to the presence of sodium chloride and sodium sulphide. Besides, its surface growth may prevent it from being seriously affected by such salts.

Despite the fact that ammonium sulphate is considered the best nitrogenous fertilizer for rice, the results clearly show that nitrogen fixation by the alga is reduced to about 50 per cent in the presence of 21 mg. ammoniacal nitrogen per litre medium; but is almost completely inhibited at 105 mg. ammoniacal nitrogen per litre. This closely agrees with the work of ALLEN (1956) on *Anabaena cylindrica*, and with that of TAHA (1964) on *Calothrix elenkinii*. Also ABOUL-FADL *et al.* (1964) found that the application of ammonium sulphate in the rate of 75 or 150 kg. per feddan had an injurious effect on nitrogen fixation by *Tolypothrix tenius*. In practice, it is the custom to add ammonium sulphate equivalent to a minimum of 20 kg. of nitrogen per feddan three or four weeks after the transplantation of rice. To overcome any harmful effect of nitrogen, it is possible to inoculate the soil with alga during transplanting, and to add half of the recommended quantity of the manure after the lapse of three or four weeks after transplantation.

When dealing with the results of the effect of asparagine, it is well known that organic manures, especially farm-yard manure or compost are used. In normal soils, the decomposition of organic manure usually takes place under aerobic or slightly anaerobic conditions, but in wet rice fields decomposition mostly occurs under water-logged or anaerobic conditions. The main effect of restricting the oxygen supply during decomposition is to delay the production of ammonia. Hence, it is unlikely that organic nitrogen present in farm-yard manure or compost affects the activity of blue-green algae.

REFERENCES

ABD-EL-MALEK, Y.—RIZK, S. G. (1963): Bacterial Sulphate Reduction and the Development of Alkalinity. 11. Laboratory experiments with soils. J. Appl. Bact., **26,** 140.

ABOUL-FADL *et al.* (1964): Nitrogen Fixation by the Blue-green Alga, *Tolypothrix tenius*, as Affected by Ammonium Sulphate, Compost, Straw and Superphosphate with Special Reference to its Effect on Rice Yield. J. Soil Sci., U. A. R., **4**, 91.

ABOUL-FADL *et al.* (1965): The Effect of Nitrogen Fixing Blue-green Alga, *Tolypothrix tenius* on the Yield of Paddy. The 1st. Con. of Microbiology, U. A. R., 1965.

ALLEN, M. B. (1965): Photosynthetic Nitrogen Fixation by Blue-green Algae. Scientific Monthly. U.S.A., **83**, 2.

EL-NAWAWY, AHMED S. *et al.* (1962): Economical Studies on Alga in Egypt. 1. Effect of New Isothiouronium Derivatives of Arylmercaptoalkane Carboxylic Acids on the Paddy Flora of Algae in Egypt. J. Soil Sci., U. A. R., **2**, 3.

EL-NAWAWY, AMIN S.—LOTFY, M.—FAHMY, M. (1958): Studies on the Ability of some Blue-green Algae to Fix Atmospheric Nitrogen and their Effects on Growth and Yield of Paddy. Agric. Res. Rev., Min. of Agric. Cairo, **36**, 308.

JACKSON, M. L. (1958): Soil Chemical Analysis, Constable and Co. London.

STURGIS, M. B. (1957): The Year Book of Agriculture, U. S. Dept. of Agric.

TAHA, M. S. (1964): The Effect of Nitrogen Compounds upon Growth of Blue-green Algae and Fixation of Molecular Nitrogen by them. Mikrobiologia, U. S. S. R., **30**, 397.

WATANABE, A. (1962): Effect of Nitrogen Fixing Blue-green Alga, *Tolypothrix tenius* on the Nitrogenous Fertility of Paddy Soil and on the Crop Yield of Rice Plants.

WATANABE, A.—NISHIGAKI, S.—KONISHI, C. (1951): Effect of Nitrogen Fixing Blue-green Algae on the Growth of Rice Plants. Nature, **168**, 748.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 329—346 (1968)

EFFECT OF NITROGEN FERTILIZATION ON THE YIELD OF KENAF

(HIBISCUS CANNABINUS L.)

By

F. T. ORABY

INSTITUTE OF AGRICULTURE, ZAGAZIG

The green yield of stalks, the yield of fibers increased by the application of 100 kg. of calcium nitrate (15.5 per cent N). However, application of 200 kg. of calcium nitrate increased the yield of seeds.

Introduction

In view of the rapid growth of the kenaf plant, a fertilizer treatment is an important condition for the achievement of satisfactory yields when the crop is grown intensively. Investigations carried out in Manchuko by INADOME and IKEDA in 1938 demonstrated the necessity for a supply of the three major nutrients, nitrogen, phosphate and potash. In South Africa, GOLDSCHMIDT (1950) stated that the wildestokroos *(Hibiscus cannabinus*, L.) reacted very favourably to phosphatic and nitrogenous fertilizers. Yields of fiber have been stepped up by 50 per cent in Java by green manuring with *Mimosa invisa*, together with an application of ammonium sulphate at the rate of 500 pounds per acre (HAARER 1952).

SEALE *et al.* (1952) stated that yields of green stalks and fiber were significantly increased by the application of nitrogen in Florida. JONES *et al.* in 1953 reported that high contents of nitrogen and potash and moderate phosphorus in the soil produced an average yield of 2800.79 kg per hectare and that the unfertilized plants produced low yields. In Mauritius, STAUB—LIMFATE (1953) stated that kenaf should be treated with 500 pounds per acre of a 4 : 8 : 12 fertilizer mixture. In terms of pure nutrients this corresponds to 20 pounds N, 40 pounds P_2O_5 and 60 pounds K_2O per acre. In the Phillippines, MAXIMO (1954) stated that kenaf *(Hibiscus cannabinus* L.) fertilized with ammonium sulphate at the rate of 100, 200 and 300 kg per hectare, all the treatments except the 100 kg plots had yielded significantly more fiber than the control. The plants had produced more capsules and seeds. JACOP—UEXKULL (1958) recommended, when using straight fertilizers for kenaf, 30—60 pounds of nitrogen, i.e. 150—200 pounds of ammonium sulphate (20 per cent N). NAZIF (1958) in Egypt reported that best yields were obtained by the manuring rates of 100—150 kg of a nitrogenous fertilizer per acre.

Materials and Methods

Two experiments were carried out at the farm of the High Institute of Agriculture at Zagazig — U. A. R. during the seasons of 1959 and 1960. A clay loamy soil which had previously been planted to Berseem *(Trifolium alexandrinum)* was plowed twice with a tractor and levelled twice. No farm yard manure was used before plowing. Plowing, levelling and ridging were done at the right time. The amount of seed used per plot was 42 grams of kenaf variety (Giza 3). This is a rate of seeding 10 kg/acre. The seeds were treated before sowing with Orthocide 75 at manufacturer rate in order to insure even stand and to avoid replanting. The nitrogen levels tested in both seasons were 0, 100 and 200 kg of calcium nitrate (15.5 per cent N) per acre. Nitrogen fertilizer according to the previous mentioned levels; 0, 400, 800 grams of calcium nitrate (15.5 per cent N) were spread in each plot, 35 days after sowing. Plants were irrigated every 10 days during their life period. Hoeing had been carried out three times from the time of germination until the plants were 50 days old. The plants in both 1959 and 1960 seasons were harvested when the colour of the lower capsules changed from green to yellow and those lower capsules became dry. The plants were cut with a hoe near the soil surface and then tied in small bundles and weighed immediately. The capsule bearing ends of the stems were cut three days from harvest. These upper parts were left in the field so that the capsules had time to dry. The bundles of the stalks then were set in a small canal in the farm, filled with stagnant water which was flooded every three days until retting was completed. Then the retted stalks were thoroughly cleaned and the retted fibers were stripped by hand, re-washed with clean water and left to dry in the sun then weighed. The dry capsule bearing stem ends were beaten with a stick to thresh the seeds. The weight of the clean seeds was then recorded.

Results

The green yield per acre. The effect of nitrogen on raising the green weight of kenaf was easily detected in both seasons of experimentation.

In the 1959 experiment, the green yield increased from 29.4 tons per acre in the control plots to 30.2 tons and 30.7 tons under the application of 100 and 200 kg of calcium nitrate (15.5 per cent N) per acre respectively as shown in Table 1. The difference between the yield of the control plots and the 100 kg of calcium nitrate application was statistically significant. There was no significant difference between the 100 kg and 200 kg levels of calcium nitrate.

In the 1960 experiment, the response to the different levels of nitrogen fertilizer used, was in all cases statistically significant.

The fiber yield per acre. It was observed in the 1959 experiment that nitrogen fertilization had no effect on the yield of dry fiber per acre. The yield of dry fiber per acre was 1843.20, 1900.80 and 1848.00 kg after the appli-

Table 1

Mean green weight in kg as affected by fertilization

Amounts of calcium nitrate (15.5% N)	Green yield in tons per acre	
	1959	1960
0	29.4	23.6
100 kg	30.2	24.4
200 kg	30.7	25.1
L.S.D. 5% Level	0.67	0.66

cation of 0, 100, and 200 kg of calcium nitrate per acre. There was no significant difference between the three yields mentioned before. In 1960 season the effect of nitrogen fertilizing on the dry fibers increased from 1708.80 kg per acre in the control plots to 1833.60 kg per acre under the application of 100 kg of calcium nitrate per acre. In 1959 and 1960 seasons it was observed that the application of 200 kg per acre decreased the yield (Table 2).

Table 2

Mean fiber yield in kg p?r acre as influenced by nitrogen fertilization

Amounts of calcium nitrate (1˙ 5% N)	Fiber yield in kg per acre	
	1959	1960
0	1843.20	1708.80
100	1900.80	1833.60
200	1848.00	1828.80
L.S.D. 5% Level	—	82.56

The seed yield per acre. The effect of nitrogen on raising the seed yield of kenaf was easily detected in both seasons of experimentation (Table 3). In 1959 the yield of seed increased from 379.20 kg per acre in the control plots to 396.00 and 415.20 kg under the application of 100 and 200 kg of calcium nitrate per acre respectively.

There were significant differences between the yields of the control plots and the yield of the fertilized ones. Also there was a significant difference between the yield of 100 and 200 kg. In the 1960 experiment, the nitrogenous fertilizer also increased the yield. The application of the first 100 kg. gave no significant increase, while the second 100 kg. gave a highly significant increase. The mean yield was 340.80, 362.40 and 416.20 kg per acre in the control plots and under the application of 100 and 200 kg of calcium nitrate per acre respectively.

Conclusions

Concerning the effect of nitrogenous fertilizer on kenaf it was observed that it increased the production of green stalks, dry fibers and seeds per acre. In both seasons, plants receiving 100 kg of calcium nitrate (15.5 per cent N) outyielded the check plots, but the addition of 200 kg affected the green yield only in one of the two seasons. The green yield increased from 29.307 tons in the control plots to 30.218 tons under the application of 100 kg calcium nitrate (15.5 per cent N). In both seasons, the addition of the different levels of nitrogen increased the yield of seed.

Table 3

Mean seed yield in kg per acre as influenced by fertilization

Amounts of calcium nitrate (15.5% N)	Seed yield in kg per acre	
	1959	1960
0	379.20	340.80
100	396.00	362.40
200	415.20	415.20
L.S.D. 5% level	16.56	22.80

It was interesting to observe that although kenaf plants receiving nitrogen did not benefit much in their height they gained a thicker diameter. The stalk diameters increased successively by raising the level of nitrogen. The stem diameters were 16.0, 16.4 and 16.8 mm for the control, 100 and 200 kg of nitrogen in the same order. This might be due to more meristematic cell division resulted in thicker diameter.

It may be concluded that for fiber production and seed production, kenaf is enough to be fertilized by 15.5 kg of nitrogen especially after legumes such as Berseem *(Trifolium alexandrium)*. That may be due to the fact that all leguminous plants develop nodules on their roots in which nitrogen-fixing bacteria live.

Acknowledgement

The present work has been done under the supervision of Professor Dr. Helal S. El Hattab, Head of Agronomy Department, Faculty of Agriculture, Cairo University, and Dr. S. Galal, Associate Professor of Agronomy, Faculty of Agriculture, Cairo University to whom I am greatly indebted for their continuous help and encouragement throughout the study.

Deep gratitude is due to Dr. M. A. Fahmi, Dean of Agricultural High Institute at Zagazig, for his overwhelming help. Without it this work could not be completed.

REFERENCES

Goldschmidt, W. B. (1950): "The Stokroos": its chemical composition and probable fertilizer in the Lowveld Soils. Farm. in S. Africa Jan.

Haarer, A. E. (1952): Jute Substitute Fibers, first published.

Inadome, T.—B. Ikeda (1938): Fertilization of Kenaf in Manchuko, Japan. J. Agric. Chem. Soc. Japan, **14**, 459—473.

Jacop, A.—H. von Uexkull (1958): Nutrition and Manuring of Tropical Crops. Fertilizer use (after Whittles M. A.)

Jones *et al.* (1953): Ministerio de Agricultora Direction de Estacions Experimentales Comission Co-operativa de fibras Circular Agricola, 5.

Maximo, S. Binos (1954): Fertilization of Kenaf with Ammonium Sulfate. Central Experimental Station Contribution No. 1770. Phillippin-Agric. XXXVIII 2—3. P. 133—145.

Nazif, S. (1958): Fiber Crops in Egypt. Min. of Agric. Egypt. Dept. of Agriculture Field Crops Research Administration, P. 10—13.

Seale, Charles, C.—J. Frank Joyner—Edward, O. Ganstad (1952): The Experimental Culture of Kenaf, *Hibiscus cannabinus* L. for Fiber and Seed in South Florida. Reprinted from Turrialba, **2,** 99—105, July—September.

Staub, S.—Limfate, E. (1953): Kenaf ih Mauritius. World Crops, **5,** 51—53.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 333—340 (1968)

OOMETRICALLY DEMONSTRATED CORRELATION OF EFFICIENT CHICKEN HATCHING AND THE GRADE OF CURVATURE OF EGG SHELLS

By

O. B. Jakab, E. Tamássy

INSTITUTE OF GENETICS, HUNGARIAN ACADEMY OF SCIENCES, ANIMAL GENETIC DEPARTMENT, GÖDÖLLŐ

When applying the new measuring process introduced in oometry (axis dimensions, data on crossings, profile index, etc.), more reliable information can be gained for choosing egg-shapes which might guarantee increased hatching results. Our measuring experiments show promising correlation of the curvature of egg-shells and the results of hatching. In general, eggs with slight curvature at the ends, do not get hatched while those with larger curvature hatch well. However, we are looking for other indices independent of the curvature and which, together with it, might grant a still more reliable basis for the efficient choosing of eggs.

Introduction

The fundamental geometric-mathematical relations in the eggs of bird species not domesticated in this country, and the determination of egg-morphological and oometric elements, respectively, had been first dealt with in 1949—50 (Radetzky) before Schönwetter's (1960) similar, however, more broadly expanded and intensified activities. Further oometric examinations in this country have also been focussed on the eggs of the avifauna (Jakab 1962, 1963) but they were also extended to the eggs of domesticated birds; in the latter case, however, the stress was laid rather on practical and economic aspects (Jakab 1964).

For characterizing the shape of egg, authors apply a new index as described in this paper: the curvature of egg shell. Relationships between this new index and the hatching rate are examined and also the characteristics which, together with the curvature, might render the prediction for hatching even more reliable. It is well known how important the shape of egg is when choosing the eggs before having them hatched. The problem concerning the correlation of the results of hatching and the form of egg had been tried to get solved oometrically, too (Beke—Lacza 1954, Tóth 1956, Gergely 1957, Bögre 1964, Kiss 1963, 1965). Generally, the shape of egg is characterized by the profile-index of the egg, and the conclusion has been drawn that the hatching of eggs is safer with certain index numbers. Profile index: the quotient of the longitudinal and latitudinal (short) axis (H/R; e.g. 57.65/41.7 =

1.38). From measuring data and their combinations applied at home and abroad so far, only a general picture of the egg-shape can be established: e.g. typical, stumpy, lengthy and roundish shape (RADETZKY 1950, SCHÖNWETTER 1960, PRYNNE 1963). No information is given on the grade of curvature in certain shell-parts and shell-sections in the length of the egg. Curvatures and differences in curvature of these shell-parts and shell-sections can be expressed with great accuracy by applying the measuring instrument already published and patented.

Material and Method

The egg is sunk first with the pointed and then with the blunt (roundish) end into the moulds of the instrument; the holes have regularly increasing diameters. The length of the egg protruding from the mould is measured with the instrument having an accuracy of one hundredth mm (Fig. 1). If the sinking rates are measured on the longitudinal axis of the egg reckoned from the axis-end corresponding with the measuring, and then if on the spots obtained, the straight lines that correspond with the size of the applied mould-diameters as well as the latitudinal axis — through the point of the axis-intersection — are measured, the accurate profile of the egg will be obtained (Fig. 2). The lines of the mould-diameters crossing the longitudinal axis at right angle, characterize — with their distance measured from the ends of egg, i.e. with the rate of sinking — the curvature of the corresponding shell sections in the direction of the egg-ends (JAKAB 1962). The rate of sinking and size of curvature (bend), respectively, can also be given by expressing absolute sinking in the percentage of the longitudinal axis.

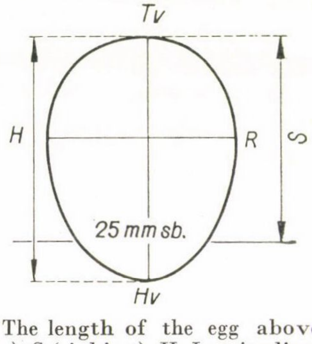


Fig. 1. The length of the egg above the mould (sb.): S (sinking). H: Longitudinal axis R: latitudinal (short) axis, Tv: Round-end, Hv: pointed-end, —: axis-crossing (measured from Tv: h).

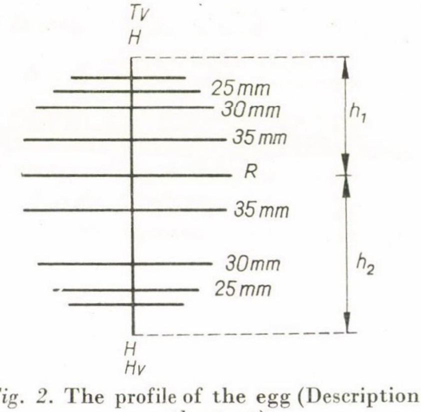


Fig. 2. The profile of the egg (Description in the text)

For examining the correlation of hatching results and the rate of egg shell curvature, in the year 1963—1964 the curvatures of more than thousand eggs were measured at the Poultry-hatching Station in Komárom. It was found that the rate of shell curvature exerted more influence on hatching result than did the profile index. Viz., when some of the eggs with similar index number and with identical order of magnitude got hatched and, in the course of hatching, others died off or got choked, — it was found that eggs having bigger curvature proved to be safer for hatching.

Results

Shell curvatures in both ends of the eggs examined in 1963, were measured with moulds of 40, 35, 30, and 25 mm. Integrating the corresponding hatching ratios and the curvature values obtained, — the closest relationship was gained with the curvature measured by the 25 mm mould (Fig. 3). Afterwards, only curvatures measured with that mould were taken into consideration. Theoretically, curvature values expressed in per cent, seem to be more characteristic of the egg shape: on the basis of observations, however, the absolute degree of sinking seemed to be in closer relation with the efficiency of hatching. Thus, henceforth, the absolute curvature-degree will be used; from practical viewpoint, too, this can be treated better and can be read directly.

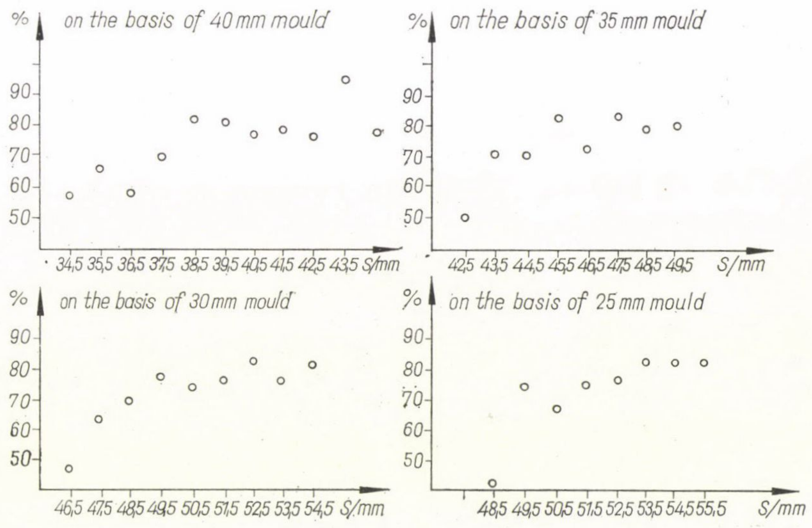


Fig. 3. Correlation in the round-end curvatures measured with different moulds, (S/mm and hatching percentage

The curvature of both ends of the egg was measured and studied how the hatching ratio developed with the different curvature-degree of round and pointed end. In 1963 the curvatures of altogether 574 eggs intended for hatching, were measured. 473 eggs were hatched which means that the average hatching scale of the eggs examined was 76.1 per cent. Curvatures were measured in the above described way and with an accuracy of two places of decimals, being then included into classes of 1 mm "width" (Table 1).

The results show the hatching of eggs belonging to classes with a blunt-end curvature below 52 mm, to remain always below the average 76,1% while curvatures above 52 mm showed, in every case, a higher hatching percentage (Table 2).

Table 1

Results obtained according to blunt-end curvatures of the egg

Curvature-size of the blunt-end	Total number of eggs	Number of eggs hatched	Number of eggs not being hatched	% of hatching
49	17	7	10	41
49—49.9	39	29	10	74.4
50—50.9	85	57	28	67.1
51—51.9	109	82	27	75.2
52—52.9	130	101	29	77.7
53—53.9	106	88	18	83.0
54—54.9	53	44	9	83.0
55	35	29	6	83.0

Table 2

Results obtained according to the pointed-end curvature of the egg

Curvature-size of the pointed end	Total number of eggs	Number of eggs hatched	Number of eggs not being hatched	% of hatching
48	34	13	22	35
48—48.9	91	62	29	68.1
49—49.9	116	93	23	80.2
50—50.9	115	100	15	87.0
51—51.9	86	61	25	70.9
52—52.9	75	62	11	84.9
53—53.9	42	33	9	78.6
54	17	14	3	82.4

Thus, it can be seen that the correlation of curvature and hatching percentage might be divided — with the curvature of both egg-ends —, into two phases: increasing and stagnant phase. Viz., up to a certain value the hatching increases parallel to curvature; after it the ratio might be considered permanent.

The choosing is performed according to the curvature of the blunt (roundish) end on the basis of the following consideration: between the average of curvature at pointed and blunt ends there exists a very close correlation. After classifying eggs according to curvature of one end, and averaging the curvature of the other end of those belonging to the given classes, the correlation is shown in Fig. 4. Between the mean of eggs being classified according to blunt-end and the average of the pointed-ends belonging to them, the correlation coefficient will be $r = 0.998$. In the case of such high coefficient the correlation can be considered almost function-like, and the equation of the regression line expressing correlation, is the following: $y = 0.92x + 2.76$.

On the basis of measurings performed so far, it can be established that New-Hampshire eggs the blunt-ends of which are more than 52 mm, show better hatching results than the average. Of course, this limit value has to be determined separately for each egg-variety. We should like to stress the theory according to which the most reliable information on the probability of hatching can be obtained by measuring shell curvature. Comparing the results with

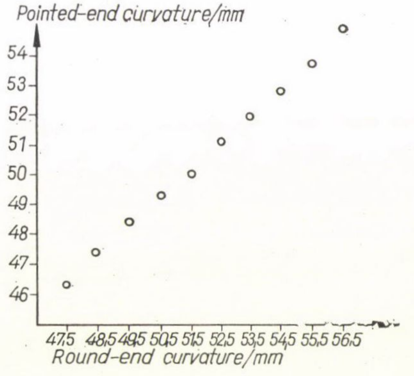


Fig. 4. Correlation in the curvature of the two ends of the egg

the correlation of profile-index and hatching percentage as used up to now: if there does exist such profile index or phase of profile index value with which eggs hatch better than in other cases, — selection on the basis of the curvature of the egg seems to be considerably more efficient.

On the occasion of the 1964 hatching, selection was performed according to shell curvature by guess work. Samples were taken from such eggs on 4 farms; the values of shell curvature were measured and the hatching percentage was studied. According to farms, these were: 95.5 per cent, 93.4 per cent and 93.4 per cent; the hatching ratio of all the eggs examined, was 94.3 per cent. Considering that out of these eggs only very few were not hatched, no considerable difference showed itself between the hatching ratios of the shell curvature classes, consequently the effect of curvature differences could not in these cases be measured. However, measured shell curvature values proved that selection "by guess work" had separated the majority of eggs with low shell curvature. The relative frequencies of shell curvature values in these well-hatching eggs were also compared with the relative frequencies of shell curvature values in separately measured 300 eggs that had not been hatched (Fig. 5). The two histograms, when compared to each other seem clearly to be shifted. Eggs being more pointed than those with a 52 mm round-end curvature are more rare in hatched eggs, — while in case of non-hatched eggs they are more frequent. As can be seen, the ratios have turned at the previously established 52 mm.

A further task is to elucidate correlations between shell curvature and other physical properties of the egg. E.g.: egg-length and absolute value of sinking show a very good correlation. Latitudinal axis and curvature do not

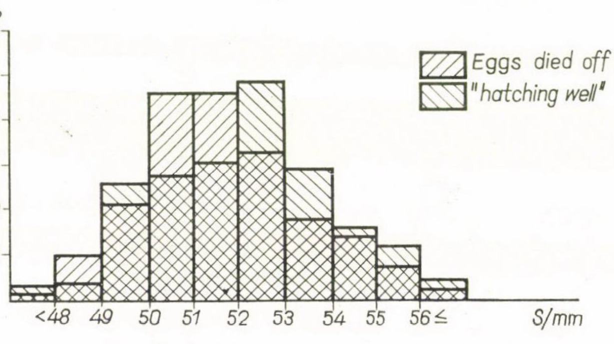


Fig. 5. Relative frequencies of shell curvatures in well-hatching and non-hatched eggs

display such a close relation, however, it seems that a certain combination of these two is in closer correlation with hatching percentage than when only the size of curvature is taken into consideration. Correlation seems to be even closer if the data of axis-crossings measured from the roundish end and expressed in percentage, are also combined into the latitudinal units (Fig. 6). In the figure it can be seen that if latitudinal axis gets bigger, the average size of shell curvature increases. On the other hand, within a latitudinal unit, with the percentual increase in the size of axis-crossing, shell curvature percentages are reverse. Furthermore, if the spot of axis-crossings is of 43—35 per cent, eggs get generally hatched; at 46—47 per cent their getting choked occurs rather in the middle of the graph; those having less or more curvature, do hatch; at 48—49 per cent the percental curvature of the eggs hatched is generally higher than that of the non-hatched eggs.

Certainly, the results gained so far allow us to hope that the efficiency of hatching can be increased by selection performed on the basis of shell curvature; the dying off and choking can be eliminated in a high percentage and the selected eggs remain utilizable for general consumption. When, on the basis of the instrument, selection is rendered suitable for large-scale application, the utilization of the hatching equipment can also be increased.

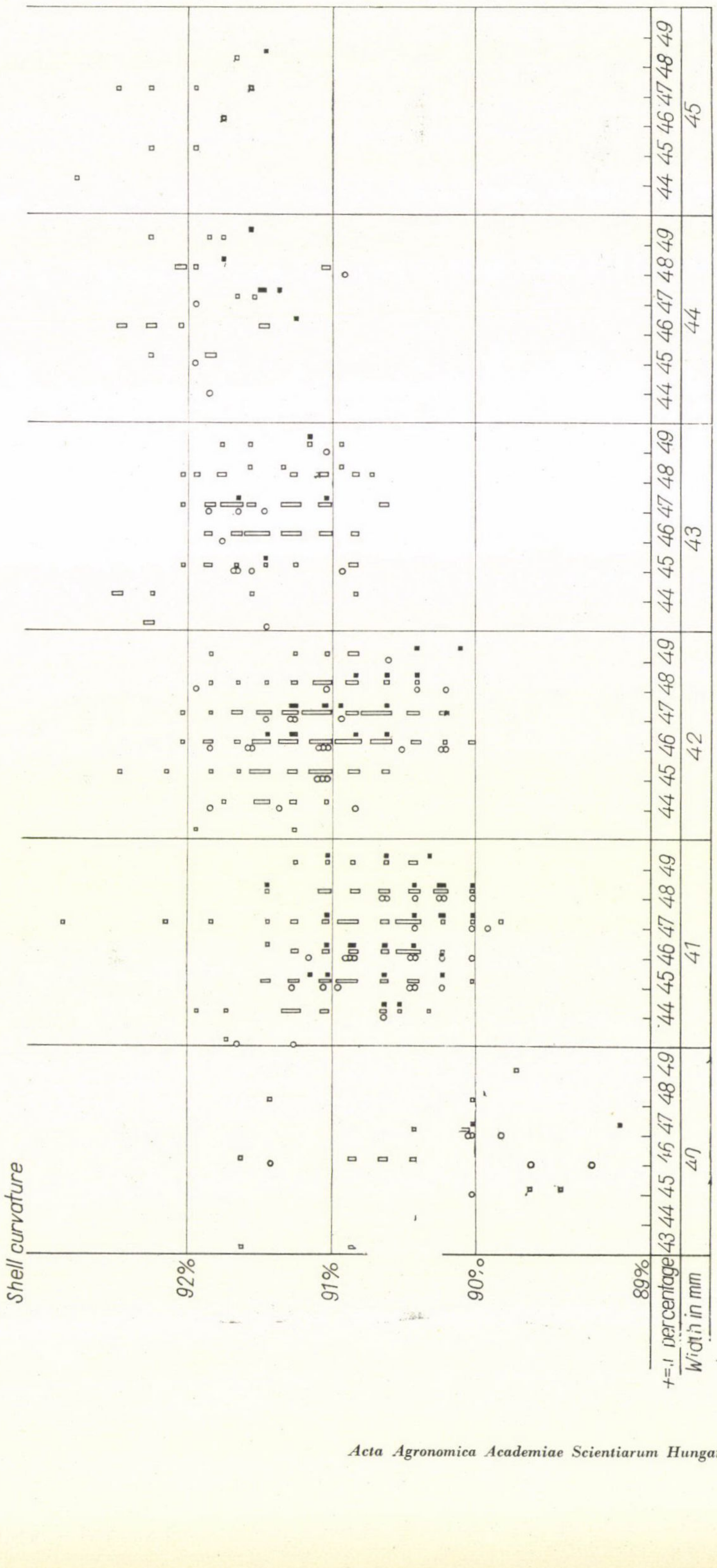


Fig. 6. R axis, percentual axis-crossing correlation of the percentual shell curvature and the hatching ratio. Eggs: hatched: □; second choked: ■; II. died off at second candling: ○.

Acknowledgement

Thanks are due to the leaders and workers of the Komárom Hatching Station for their kind assistance; special thanks are due to director Gy. Szabó and to manager J. Takács.

REFERENCES

BEKE, B.—LACZA, J. (1954): Baromfikeltetés (Poultry Hatching). Mezőgazdasági Kiadó, Budapest, 35.

BÖGRE, J. (1964): A tyúktenyésztés kézikönyve (A Manual of Hen Breeding). Mezőgazdasági Kiadó, Budapest, 271.

GERGELY, B. (1957): A baromfitenyésztés kézikönyve (A Manual of Poultry Breeding). Mezőgazdasági Kiadó, Budapest, 47.

JAKAB, O. B. (1962): An Oological Measuring Method for the Percental Demonstration of the Curvature of Egg Shell. Acta Zoologica, **8**, 3—4.

JAKAB, O. B. (1963): A New Measuring Apparatus to Demonstrate Sectional Curvature of the Egg Shell in Per cent. Acta Zoologica, **9**, 3—4.

JAKAB, O. B. (1964): Az új oometriai eljárás tudományos és gyakorlati alkalmazása. (The Scientific and Practical Application of the new Oometry Method). Állattani Közlemények, **51**, 163.

JAKAB, O. B. (1965): Eljárás és berendezés egymáshoz igen hasonló tojásalakú idomok szétválasztására (Method and Equipment for Separating very Similar Egg-shaped Forms). Országos Találmányi Hivatal 151586 sz. leírása. (Patent No. 151586.)

KISS, I. (1963): Milyen nagyságú és alakú legyen a keltető tojás? (Of what Kind of Size and Shape Should Be the Egg for Hatching?). Baromfitenyésztés, **4**, 14.

KISS, I. (1965): Gépi lúdtojáskeltetési technológiák összehasonlító vizsgálata (A Comparative Examination of Technologies for Mechanical Hatching of Goose Eggs). Agrártudományi Egyetem, Mezőgazdaságtudományi Karának Tudományos Értesítője, Gödöllő, **3**, 32—33.

PRYNNE, M. (1963): Egg-shells. London, 87—88.

RADETZKY, J. (1950): Tojáshatározó (Egg Index). Kézirat (Manuscript), 3—4.

SCHÖNWETTER, M. (1960): Handbuch der Oologie. Berlin, **1**, 7—8.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 341—346 (1968)

THE CHANGE OF CATALASE ENZYME ACTIVITY WITH TABLE-VINE VARIETIES IN THE COURSE OF VEGETATION

By

J. SZALAI

DEPARTMENT OF NURSERY GARDENS AT THE COLLEGE FOR HORTICULTURE AND VITICULTURE, BUDAPEST

In the course of vegetation the catalase enzyme activity was examined on the basis of NOVOPAVLOVSKAJA's (1960) statement, in early and late table-vine varieties being grafted on 5 BB-stock. It was established that the catalase enzyme activities of the examined varieties differed from one another during the vegetation period which was, however, not a variety character. On the basis of catalase enzyme activity varieties could not be segregated.

Introduction

Several researchers, thus: DECACH (1960), DRBOGLAV (1960), NOVOPAVLOVSKAJA (1960), PINEVICS (1961), ITO-HAYASHI (1961), FIALOVÁ-DOBREMISLOVÁ (1962) and KOZMA (1963) are unanimously expounding in their works that the enzyme activity of varieties, thus the catalase enzyme activity, too, is characteristic of the different vine varieties. The activity of that enzyme is in correlation with the age of vine, nutriment and climatic effects as well.

Materials and Method

This type of experiments has been performed on the vine plantation of the Balatonaliga State Farm with the following table-vine varieties: one early *(Chasselas)*, one medium *(Kecskemét virága)* and two late varieties *(Afuz-Ali* and *Italia)*. The above-mentioned varieties grafted into 5 BB root stocks had been planted in 1951. Throughout the whole vegetation period the examined leaves were plucked, on each occasion in 5 repetitions, from the low, medium, and upper leaf levels. They were examined by way of Prof. FRENYÓ's gasometric method. The time of taking sample was always between 7 and 8 a. m. When evaluating the experiments, FELFÖLDY's (1957) statement was taken into consideration; according to which leaves were not to be mixed on the occasion of sampling. When making comparative evaluation of the variety examined, it is however, difficult to represent three leaf levels with each variety. Therefore, it deemed to be promising to apply a method according to which the foliage activity of the varieties is compared on column-diagram. The foliage-activity was obtained in the following manner. With each variety the values of the low, medium and upper leaf-levels having been read off our measuring instrument were averaged together; in this way we got an index characteristic of the variety, and thus the comparison can be demonstrated expressively.

Results

The evaluation of the data obtained in the year 1963, is shown in Fig. 1.

With the early *Chasselas* variety there occurred, in the course of vegetation intensive catalase activity on two occasions at flowering in the early days

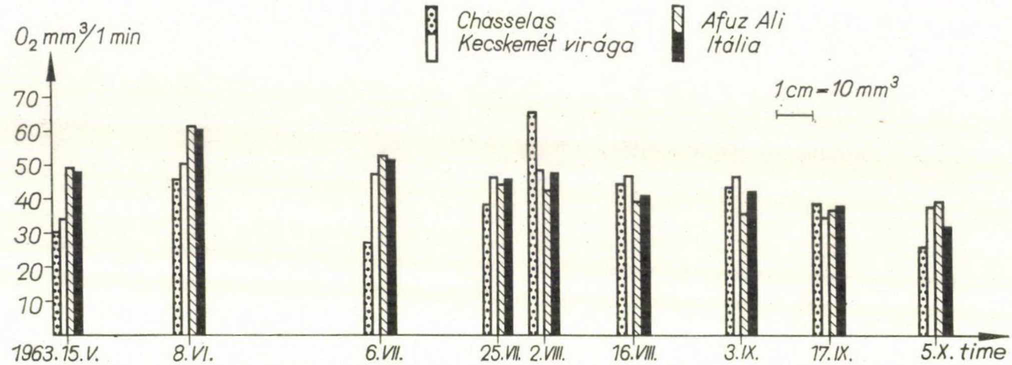


Fig. 1. Change of catalase activity of the foliage in table vine varieties during the vegetation period in the year 1963

of June and before the start of maturing at the beginning of August. From September on, the catalase activity of the foliage showed a decreasing tendency.

The same tendency appears with the variety *Kecskemét virága*. Its activity was the most intensive on June 8, while from July to the end of the vegetation, slight fluctuations could be observed. The intensity was not increasing before fruit ripening i.e.: vintage.

As to the variety *Afuz-Ali* the activity is the most intensive at flowering. From the time of flowering up to the middle of September, a decrease can be experienced; before ripening, however, an increase can be seen again.

With the variety *Italia* the enzyme activity is high at the time of flowering in June and in the first week of September. From the second half of September it gradually decreased. With the repetitions the standard deviation was obtained by way of the Dixon test. This was — in the course of the year — 10.2 per cent with *Chasselas*, 9.9 per cent with the variety *Kecskemét virága*, 10.4 per cent with *Afuz-Ali* and 10.6 per cent with *Italia*.

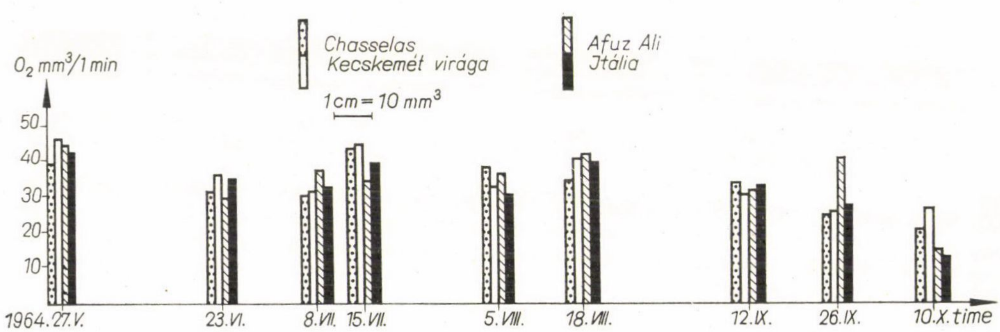


Fig. 2. Change of catalase activity of the foliage in table vine varieties during the vegetation period in 1964

Evaluation of the data obtained in 1964. With the *Chasselas* variety the activity is the most intensive by the end of May, in the middle of July and September. From July 8 to July 15 the activity of the foliage increases by leaps. The length of sunshine and the temperature were high, the precipitation was 7 mm at that time.

In the case of the variety *Kecskemét virága* the activity was the highest at the end of May and in the middle of July and in the middle of August. Before vintage the activity was not increasing in that year either. It is to be mentioned that according to measurings on August 18, there was a rainfall of 6 mm.

With the variety *Afuz-Ali* the highest values were obtained on May 27, July 8 and August 18 as well as on September 26. Up to the end of September the activity was decreasing gradually.

With the variety *Italia* May 27, July 15 and August 18 are the most intensive seasons. From the last days of September the activity decreases gradually in this variety, too. The standard deviation values of the repetitions, as established by the Dixon test, were the following: *Chasselas* 11.4 per cent, *Kecskemét virága* 12 per cent, *Afuz-Ali* 11.7 per cent, *Italia* 11.9 per cent.

Evaluation of the data obtained in 1965 (Fig. 3).

With the variety *Chasselas* the catalase activity is the most intensive on May 24 and then it decreases gradually. On August 22 the value is high again, however, it diminishes parallelly with the ageing of leaves.

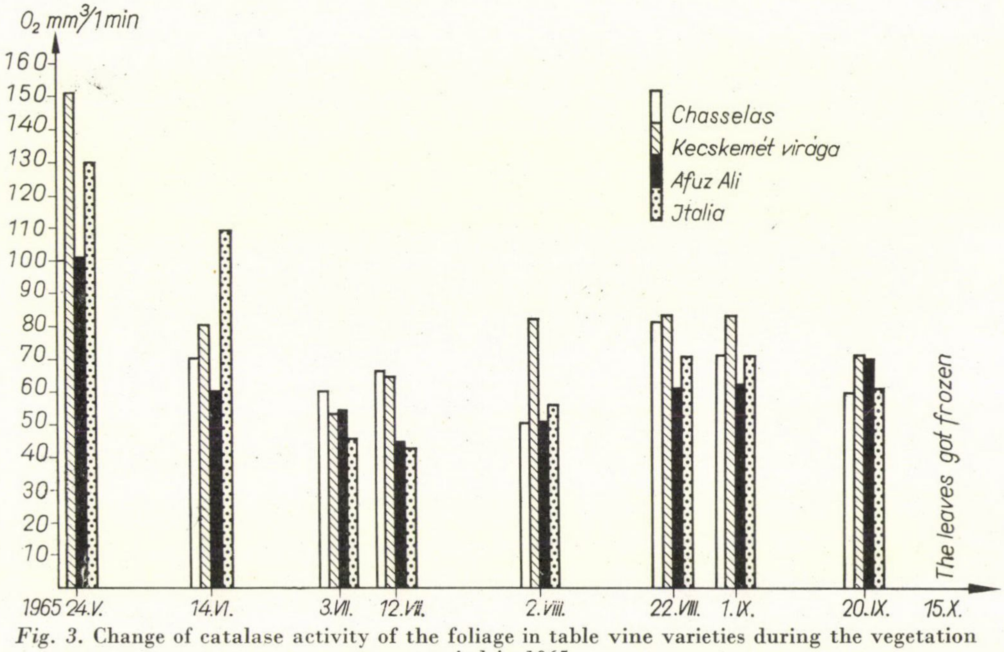


Fig. 3. Change of catalase activity of the foliage in table vine varieties during the vegetation period in 1965

In case of *Kecskemét virága* the highest activity occurred on May 24, then decreased gradually to July 3. Then it increased again and remained, in general, at the same level.

As to the variety *Afuz-Ali*, here, too, the activity was the highest on May 24; then it gradually decreased to July 12 and from that time on, a successive increase could be observed till the end of vegetation.

Regarding the variety *Italia*, the highest value observed on May 24, gradually decreased up to July 12, and afterwards a successive rise appeared which turned into decrease towards September 20.

Measurings, on October 15, could not be performed because of the leaves getting destroyed by frost.

Average standard deviation of the repetitions obtained by the Dixon test, are: *Chasselas* 10.7 per cent, *Kecskemét virága* 10.5 per cent, *Afuz-Ali* 11.1 per cent, *Italia* 11.2 per cent.

Evaluation of the data of 1966. With the variety *Chasselas* the highest activity was recorded on May 7; it decreased gradually and was high on October 22.

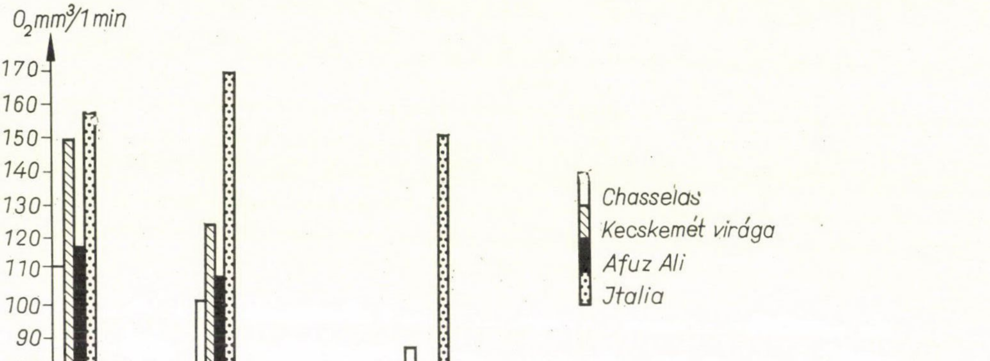


Fig. 4. Change of catalase activity of the foliage in table vine varieties during the vegetation period in 1966

In the case of the variety *Kecskemét virága* the activity of the catalase enzyme was high on May 7 gradually decreasing till September 28. On October 22 it was increasing.

The variety *Afuz-Ali* showed high activity on May 7 decreasing gradually and showing again a rise on October 22.

The variety *Italia* displayed very high catalase enzyme activity on June 5; it was gradually decreasing from July 18 till September 28; then the catalase activity increased till October 22.

The average standard deviation of the repetitions evinced by the Dixon test, are: *Chasselas* 9.9 per cent, *Kecskemét virága* 10.3 per cent, *Afuz-Ali* 10.6 per cent, *Italia* 10.4 per cent.

Conclusions

According to variety, to developmental stage, and depending on the environment, the deviations of metabolism can be well characterized by the activity of the catalase enzyme. The decrease of the catalase enzyme is in correlation with the ageing of leaves and with the approaching of the end of vegetation period; it submits information on the changes of metabolism at every period of time and, owing to its interrelationships, the catalase enzyme activity, may be suitable for being a general index of the changes of metabolism.

On the basis of the data obtained, the enzyme activity of different varieties examined is divergent, however, not a character of variety. According to the conclusions of NOVOPAVLOVSKAJA (1960), the catalase activity is different with each vine variety and proves to be a character of variety; our data have not proved that statement.

The examined varieties differed from one another during flowering and the most intensive catalase activity appeared at that very phase. This finding of ours have been considerably supported by the experiments of KOZMA (1963) according to which, during the phase of flowering, even in certain clone-types a significant difference can be evinced in the catalase activity.

Acknowledgement

Author would like to express his thanks to Professors and Heads of Department E. PROBOCSKAI and V. FRENYÓ for their valuable theoretical and practical advice.

REFERENCES

DECACH, P. C.—COMMISIONG, K. *et al* (1960): Interrelationships of Catalase, Peroxidase, Hematin and Chlorophyll. Plant Physiol., **5**, 599—604.

DRBOGLAV, M. A. — Дрбоглав, М. А. (1960): Активность каталазы в тканях виноградной лозы. Биохимия виноделия., **6**, 253—260.

FIALOVÁ, S.—DOBREMYSLOVÁ, M. (1962): The Activity of Catalase and Phosphatase in Wheat when Controlling the Growth Rate. Biol. Plant., **3**, 182—190.

Frenyó, V. (1962): Neues Verfahren zur Feststellung der Katalase Aktivität von Pflanzen am freien Feld. Annales Univ. Sci. Sectio Biol., **5**, 131—136.

Felföldy, L.—Kalkó, Zs. (1957): Kísérletek növényi katalázzal, Módszertani kérdések (Experiments with Plant Catalase. Problems of Methodology.)

Ito, S.—Hayashi, S. (1961): Effect of Limited Oxygen Supply on Activities of Catalase Peroxidase and Cytochrome Oxidase in Germinating Rice Seeds. Proc. Crop., **1**, 97—100.

Kozma, P. (1963): A szőlő termékenységének és szelektálásának virágbiológiai alapjai (The Flower-biological Bases of the Productivity and Selection of Vine.) Akadémiai Kiadó, 494.

Novopavlovskaya, N. V. — Новопавловская, Н. В. (1960): Активность каталазы у корнесобственных растений винограда и привитых на морозостойке подвои. Всесоюзная Центр. Ген. Лабор. **9—10**, 79—87.

Pinevich, V. V. — Пиневич, В. В. (1961): Влияние различных форм азотное удобрений на активность каталазы и пероксидазы в семени пшеницы и ячменя. Физиол. раст. **2**, 205—212.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 347—351 (1968)

RECENT RESULTS OF APPLYING ORGANIC MANURE INTO SANDY SOIL AT DIFFERENT DEPTHS

By

F. HEPP

RESEARCH INSTITUTE OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY OF THE HUNGARIAN ACADEMY OF SCIENCES, BUDAPEST

When setting up the experiment, the sandy soil was uniformly cultivated to a depth of 50 cm but the organic manure was placed at different depths. According to the results of 5 experimental years, in 2 instances organic manuring at 20 cm, in other 2 cases at 50 cm brought about significant yield increases. In 23 instances there was no statistically demonstrable yield increase.

Introduction

In Hungary organic manuring combined with deep cultivation (50—70 cm) of sandy soils is traditional in planting vineyards.

Concerning plant cultivation in the field, EGERSZEGI (1953) was the first to study under experimental conditions the effect of organic manure worked deeply into sandy soil on the yield. The amelioration method elaborated by him for sandy soils may be adopted only together with deep cultivation (ploughing, loosening).

The experiments of KLIMES-SZMIK (1954) and of DVORACSEK—DVORACSEK (1960) have thrown light on those fundamental physical changes that occur in sandy soils due to the effect of deep cultivation under natural conditions in Hungary.

DVORACSEK (1966) and HEPP (1965, 1967) have published the results obtained in the course of studying the effects of various cultivation methods and manuring combinations.

Material and Method

From the experiments — described in the cited literature — by comparing various soil cultivation methods, it cannot be established whether deep cultivation or the deep placement of organic manure is the more decisive factor in the quantitative tendency of yield on sandy soils.

The effect of manuring at different depths may be objectively evaluated only if all other factors are identical, that is, if:

a) sandy soil is of nearly the same quality to the lower limit of soil cultivation,

b) the same soil cultivation method is used,

c) manure is placed at different depths.

The effectiveness of deep cultivation probably depends on the amount and quality of applied plant nutrients and on the method of application. This is the reason why characteristically different organic matters have been used in our experiment. Cornstalk with leaves (chopped) and alfalfa hay have been used, respectively, as model materials in amounts with the same dry matter content as 600 metric quintals of farmyard manure.

On the basis of the above outlined principles, in the second part of September 1961, a small plot experiment was set up in the experimental station of the Institute at Őrszentmiklós, in the region between the Danube and the Tisza. The experiment was conducted in latin rectangle design, in 4 replications on a chernozemic calcareous sandy soil.

Treatments:

1. digging to 20 cm,
2. turning to 50 cm,
3. farmyard manure at 50 cm, in layers,
4. farmyard manure worked into soil to a depth of 20 cm,
5. corn-stalk at 50 cm, in layers,
6. corn-stalk worked into soil to a depth of 20 cm,
7. alfalfa at 50 cm, in layers,
8. alfalfa worked into soil to a depth of 20 cm.

In the first year soil was cultivated to a depth of 50 cm, except in the case of treatment No. 1, but later on only to 20 cm. In order to study the residual effect, mineral fertilizers were not applied till 1965.

Main data of an average soil sample collected from the experimental site

Depth cm.	pH		$CaCO_3$ %	total organic matter	hy_1 (hygroscopicity)	raise of water in	
	H_2O	KCl				2	5
						hours	
0— 60	6.30	6.10	3.2	1.3	0.94	265	335
60—100	6.90	6.80	19.6	0.4	0.50	290	380

Results

The precipitation conditions of the experimental site are presented in Table 1. The amount of rain fallen during the growing season of the plants concerned as well as the dates of sowing and harvesting are given in Table 2.

Table 1

Annual precipitation and its monthly distribution on the experimental site, Őrszentmiklós, 1962—1966

Year	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Total
40 years average	27	26	35	42	62	59	48	53	46	47	45	40	530
1962	30	13	68	25	46	23	49	2	41	19	192	41	549
1963	68	70	43	27	99	114	31	119	106	58	13	34	782
1964	—	36	38	21	31	157	55	56	42	163	17	81	697
1965	25	4	49	48	48	184	121	97	103	7	175	72	953
1966	42	49	32	38	47	105	144	108	11	66	89	69	799

Table 2

Amount of precipitation during the growing season of various plants

Plant	Growing seasons, stage of growth	Date of sowing and harvesting	mm	
Sorghum	from sowing to harvesting	16.5.1962—24.9.1962		141
Maize for silage	from sowing to harvesting	25.5.1963—21.8.1963		289
Rye	from sowing to spearing	23.9.1963—12.4.1964	187	
	from spearing to harvesting	13.4.1964—20.7.1964	249	
			total	436
Rye	from sowing to spearing	29.9.1964— 8.4.1965	340	
	from spearing to harvesting	9.4.1965—17.7.1965	349	
			total	689
Fodder rye	from sowing to tillering	23.9.1965—18.3.1966	418	
	from tillering to harvesting	19.3.1966—14.5.1966	60	
			total	478
Maize	from sowing to snapping	17.5.1966—19.9.1966		392

Yields obtained during the five years of experiment are summarized in Table 3.

In 1962 it was the treatment No. 4 that brought about the highest amount of green mass of sorghum. The deep placement of nutrients was not advantageous, a significantly lower yield was obtained than in case of applying farmyard manure to the surface. The effect of placing the other organic matters to various depths was similar only in tendency.

In 1963 the highest yield of maize for silage was obtained in the treatments with alfalfa. The effect of placing nutrients to various depths asserts itself but slightly when applied at a greater depth. It must be mentioned that in green mass the percentage of maize ear was considerably favourable due to the effect of treatments where the nutritive material was placed to a greater depth.

In 1964, in the third year, the residual effect of organic matters was indicated by the yield of winter rye. The yield increasing effect of treatments with alfalfa is outstanding. This is obvious if we consider that — calculated for 1 ha — 224 kg N in the form of farmyard manure, 75 kg N in that of cornstalk and 305 kg N in that of alfalfa has got into the soil.

In 1965 again winter rye was the indicator plant. Compared to treatment No. 3, only the effect of treatment No. 7 on the yield was demonstrable in a positive way in both the grain and hay yields.

On the 1st March 1967 fodder rye sown in the former autumn received a top-dressing of 50 kg N/ha in every treatment. Ammonium nitrate granulated with calcium carbonate was used as fertilizer. The afterseed maize received the same amount of this fertilizer. With one exception no significant difference

Table 3

Yields, kg/100 m² at Őrszentmiklós

Treatment	Sorghum for silage 1962		Maize for silage 1963		Rye 1964			
					grain		hay	
	weight	ratio	weight	ratio	weight	ratio	weight	ratio
1.	148.0	87.7	131.2	83.7	7.88	70.9	28.4	67.0
2.	165.2	97.9	124.8	79.6	8.24	74.1	32.8	77.4
3.	168.8	100.0	156.8	100.0	11.12	100.0	42.4	100.0
4.	203.6	120.6	154.8	98.7	15.52	139.5	42.8	100.9
5.	170.0	100.7	162.4	103.6	11.48	103.2	45.2	106.6
6.	172.0	101.9	156.8	100.0	10.52	94.6	42.8	100.9
7.	187.6	111.1	216.4	138.0	19.24	173.0	80.8	191.5
8.	195.2	115.6	212.0	135.2	16.52	148.6	69.6	164.2
LSD 5%	32.0	18.9	19.6	12.5	3.36	30.2	6.4	15.1

could be demonstrated in the effects of treatments with organic fertilizesr either in the case of green mass of fodder rye or in that of the maize's grain and stalk yields.

From the three organic matters, alfalfa has brought about the best and the longest lasting results. Its deep placement — in both cases — resulted in higher yields (except in the first year) even in the third year of experiment than the application of farmyard manure.

Conclusions

Under the weather conditions of the experiment (more rain than the average) the deep placement of organic matters into a sandy soil cultivated always to the same depth has not brought about higher yields on the average of 5 years than the usual manuring of the surface.

The soil was cultivated to a depth of 50 cm only at the beginning of the experiment, later on the depth of cultivation was 20 cm uniformly.

If precipitation conditions are unfavourable during the decisive period of plant dry matter formation, the deep placement of nutrients may exercise a more favourable influence on the yield.

The residual effect of organic manuring — regardless of the quality — could be demonstrated even after 5 years. Therefore the problem of organic manuring of sandy soils should not be neglected.

from 1962 to 1966

Rye 1965				Fodder rye 1966		Maize 1966			
grain		hay				air dry grain		air dry stalk	
weight	ratio	weight	ratio	green weight	ratio	weight	ratio	weight	ratio
9.60	73.2	23.0	71.0	69.2	71.0	58.4	91.3	56.0	87.6
10.40	79.3	23.8	73.5	73.2	75.8	59.2	92.5	52.4	82.1
13.12	100.0	32.4	100.0	96.4	100.0	64.0	100.0	64.0	100.0
14.20	108.2	31.8	98.1	88.4	91.7	64.0	100.0	63.2	98.7
13.32	101.5	32.2	99.4	84.4	87.7	64.8	100.1	62.0	96.8
12.92	98.5	29.6	91.4	83.6	86.6	59.2	92.5	58.8	91.9
16.32	124.3	38.6	119.1	94.8	89.3	62.0	96.8	58.8	91.9
13.72	104.6	30.2	93.2	90.0	93.4	62.0	96.8	59.2	92.5
2.16	16.5	5.4	16.7	16.8	17.4	3.8	5.9	6.8	10.6

REFERENCES

DVORACSEK, M.—DVORACSEK, M. (1960): Az altalajlazítás hatása és hatásmechanizmusa homokon (The Effect of Subsoil Loosening and its Mechanism on Sandy Soils). Agrokémia és Talajtan, **9**, 13—33.

DVORACSEK, M. (1966): Homokjavítási, agrotechnikai és trágyázási módszerek összehasonlító vizsgálata (Comparative Examination of Sand Amelioration, Agrotechnical and Fertilization Methods). Magyar Tudományos Akadémia IV. Oszt. Közl., **25**, 25—44.

EGERSZEGI, S. (1953): New Methods of Improving Sandy Soils by Deep Placement of Manure. Act. Agr. Acad. Sci. Hung., **3**, 317—341.

HEPP, F. (1965): Szervesanyagok eltérő mélységű alkalmazása homoktalajon (Application of Organic Matters in Different Depths in Sandy Soils). Magyar Tudományos Akadémia IV. Oszt. Közl., **24**, 41—46.

HEPP, F. (1967): A különböző mélységű szántások és a trágyázás hatása homoktalajon (The Effect of Ploughing to Different Depths and Fertilization on Sandy Soils). Talajtermékenység, **2**, 29—37.

KLIMES-SZMIK, A. (1954): Aljtrágyázott homok vízgazdálkodása (Water Regime of Deeply Manured Sands). Agrokémia és Talajtan, **3**, 75—102.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 353—358 (1968)

GERMINATION BEHAVIOUR OF THE SEEDS OF SCIRPUS ARTICULATUS L.

By

S. C. DATTA, A. K. ROY

DEPARTMENT OF BOTANY, CALCUTTA UNIVERSITY, CALCUTTA

This investigation indicates that the seeds of *Scirpus articulatus* possess dormancy. In this species, the germination-regulation mechanism is related to temperature. Light or chemical treatments do not seem to have much impact on breaking the dormancy of these seeds in contrast to alternating temperatures.

Introduction

Scirpus articulatus L., belonging to the family Cyperaceae, is found in West Bengal as a weed in rice-fields during the rainy season. It is also common throughout India and South Andamans in ponds and tanks (SUBRAMANYAM 1962). It flowers from September to November and is fruiting from December to March.

The plant propagates by means of the old stoloniferous root-stock despite of the fact that a good number of seeds are produced every year. Hence, this investigation on the seed and germination has been undertaken in order to gain an insight into a crucial phase of its life-cycle. It may be pointed out here that the germination behaviour of seeds have great value in the survival and distribution of species in specific habitats (WENT 1948, DATTA 1961a, 1961b; DATTA—CHAKRAVARTI 1962).

Materials and Methods

Fully mature and dry spikelets of *Scirpus articulatus* were collected from a rice-field in Sarsuna, 24 Parganas, West Bengal, in March, 1965. The seeds were manually separated from the spikelets that contained the mature nuts and healthy seeds selected for the present study. Prior to germination, the length and breadth of 12 lots of seeds, each containing 100 per lot, were measured by means of a millimetre graph paper. The volume of seeds was taken on triplicate sets of 200 seeds each. The weight of seeds was measured for 10 samples, each with 100 seeds per sample.

The seeds were placed in Petri dishes on moist filter paper. The dishes were watched daily for a week and the percentage of total germination recorded as well as the time in which germination was initiated. The tests were carried on triplicate lots of 100 seeds for each condition. The first appearance of the radicle was taken as the criterion for germination.

The seeds were kept in paper packets and stored at the laboratory temperature (27—32° C). Each packet was taken out at the intervals of 4, 8, 12 and 16 weeks after collection and their rate of germination studied.

The dishes were kept for germination at constant temperatures of 5° C in a refrigerator and 26, 30 and 37° C in ovens. There was darkness all the time except for a few minutes daily when the dishes were taken out to count the number of seeds that had germinated.

The seeds were also maintained at different constant temperatures (mentioned before) and then transferred to the room temperature where they were placed for another week.

In all cases, there was darkness except for a few minutes daily to watch for the effect and except upon their transference to the room temperature (laboratory temperature) when there was diffused light during day and no light at night.

The seeds were soaked in water in Petri dishes at room condition and exposed to illumination from a 60-watt light bulb put at a vertical distance of 61 cm from the dishes. At the same time, some dishes were kept for darkness in a laboratory locker and some also received diffused light during the day and no light at night.

The seeds were treated with various concentrations of potassium nitrate, sodium chloride, ammonium nitrate, manganese sulphate and thiourea. They were set at the room condition, receiving diffused light during day and no light at night.

Results

The seeds of *Scirpus articulatus* had a mean length of 1.32 mm, breadth of 1.01 mm and volume of 0.15 ml (Table 1). The mean weight of 100 seeds was 0.55 gm.

Table 1

Measurements on the seeds of Scirpus

Length (in mm)	Breadth (in mm)	Volume (in ml)	Weight (in gm)
1.32 ± 0.7	1.01 ± 0.6	0.15 ± 0.02	0.55 ± 0.04

Immediately after harvest (with no period of storage), the seeds germinated to the extent of 1.3 per cent. However, the rate continued to increase progressively with prolonged periods of storage (Table 2). Thus, 3.3 per cent germinated after 4 weeks of storage, 3.7 per cent after 8 weeks, 21.3 per cent after 12 weeks and 35 per cent after 16 weeks.

Table 2

Effect of storage on germination of Scirpus seeds

Weeks after harvest	Percentage of germination
0	1.3 ± 1.4
4	3.3 ± 2.3
8	3.7 ± 2.2
12	21.3 ± 3.1
16	35.0 ± 4.6

Exposing the seeds to constant temperatures of 5, 26, 30 and 37° C failed to break dormancy until the sixth day when there was slight germination at 30° C (Table 3).

Table 3

Relation between different temperatures and Scirpus seed-germination

Observation after day or days	Percentage of germination at			
	5° C	26° C	30° C	37° C
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0.7	0

From Table 4, it may be seen that alternation of temperatures of 26 and 30° C with room temperatures (27—32° C) has given very poor germination. On the other hand, the alternation of 5° C and 37° C with the room temperatures has yielded the highest percentage of germination.

Table 4

Relation between alternating temperatures and Scirpus seed germination

Conditions of alternating temperatures	Percentage of germination
5° C & room temp. (27—32° C)	77.8 ± 1.7
26° C & room temp.	1.0 ± 1.0
30° C & room temp.	2.3 ± 1.1
37° C & room temp.	68.0 ± 2.1
Room temp. only (2 weeks)	35.0 ± 4.6

As regards the effect of light conditions, no germination took place under continuous darkness (Table 5). However, the rate (4 per cent) was slightly improved when seeds were kept in diffused light. The maximum germination (33 per cent) occurred when the seeds were offered continuous light.

Table 5

Effect of different light conditions on germination of Scirpus seeds

Conditions of light	Percentage of germination
Continuous darkness	0
Diffused light	4.0 ± 1.2
Continuous light	33.0 ± 5.1

Table 6

Relation between chemical treatments and Scirpus seed germination

Concentration used (%)	Potassium nitrate	Sodium chloride	Ammonium nitrate	Manganese sulphate	Thiourea
0.5	0	0	2.7±1.4	2.7±1.4	1.0±0.2
0.25	0.7±1.05	1.3±1.05	4.7±0.3	4.7±0.3	0
0.20	1.7±0.6	2.0±1.6	6.3±0.9	6.0±0.9	7.0±1.5
0.15	4.3±0.53	2.0±1.7	7.0±1.5	6.2±0.7	7.0±1.5
0.10	9.7±0.34	6.0±1.5	10.0±2.1	7.0±1.5	7.0±1.5
0.05	13.3±1.9	6.0±2.1	8.7±0.8	6.2±0.7	10.0±1.6
0.025	8.3±2.6	6.0±0.11	12.0±1.7	7.7±1.5	0
0.0125	23.0±1.4	0	0	0	0
Control (only distilled water)	6.3±1.4	7.8±1.1	11.3±1.4	8.3±0.8	3.3±0.4

The results of chemical treatments on germination are presented in Table 6. It has been noticed that high concentration of 0.05 per cent of potassium nitrate and sodium chloride completely inhibited the germination of *Scirpus* seeds. At this concentration, ammonium nitrate, manganese sulphate and thiourea produced low rate of germination which was much lower than the corresponding controls. Moreover, the rate of germination increased progressively as the concentrations were decreased proportionally. In the potassium nitrate series, the rate was improved at the level from 0.10 to 0.015 per cent in comparison with the control. In the sodium chloride and manganese sulphate series, none of the chemical treatments indicated any rise in germination when compared with the controls. In the ammonium nitrate series, only a concentration of 0.025 per cent showed a slight improvement of germination over that of the control. In the thiourea series, the rate seems to increase from 0.20 to 0.05 per cent concentration after or before which the rate declined sharply.

Discussion

The present investigation shows that the seeds of *Scirpus articulatus* are very minute as revealed by their length, breadth, volume and weight (Table 1). Such dimensions follow the behaviour of weeds like *Gomphrena celosioides* and *Indigofera enneaphylla* (Toor 1964a, 1964b). Unlike these two species, the seeds of *Scirpus articulatus* possess dormancy. Table 2 indicates that 1.3 per cent of them germinate immediately after harvest (with no period of storage). From this value, the percentage of germination rises up to 35 per cent in 16 weeks after collection. This means that seeds undergo a phase of after-ripening, as a result of which germination is improved.

The effect of temperature on germination has been noted in a number of plants. The exposure of the seeds of *Indigofera enneaphylla* to temperatures of 0° C and 40° C alternately for the duration of 12 hours each approximately doubles the percentage of germination (TOOR 1964a). However, lower and higher temperatures of 0° C and 40° C respectively have a retarding effect on seed germination of *Gomphrena celosioides* (TOOR 1964b). As to the seeds of *Trichodesma amplexicaule*, different temperatures (13° C to 40° C) do not seem to affect the germination rate (SANKAR 1965). A temperature of 28° C is most suitable for the germination of seeds of *Nerium oleander;* any temperature either above or below it will limit the rate (DATTA 1961b). The effect of temperature is also marked in the present study. Keeping the seeds at constant temperatures of 5, 26, 30 and 37° C reduce s the rate of germination to the minimum. On the other hand, chilling the seeds at a low temperature for one week and then transferring to a high temperature the germination is stimulated by as much as 77.8 per cent. It appears that pre-treatment with either a low temperature (5° C) or a high temperature (37° C) is conducive to the successful germination of *Scirpus* seeds (Tables 3, 4).

In Table 5, the effect of light on germination is given. It shows that seeds will not germinate under continuous darkness. Furthermore, the percentage of germination is much higher under continuous light than under diffused light. This indicates that light can act as a dormancy-breaking agent and that the germination of *Scirpus* seeds is favoured by light.

The effect of chemicals on the germination of *Scirpus* seeds is not without interest (Table 6). Higher concentrations of potassium nitrate and sodium chloride completely retard germination. At a very low dose of 0.015 per cent, seeds fail to respond in all treatments except potassium nitrate where the rate is four times as much as the corresponding control. In general, the rate is slightly enhanced when treated with the solution of potassium nitrate, ammonium nitrate and thiourea. These three chemicals are rich in nitrogen which may have something to do with the breaking of dormancy of *Scirpus* seeds.

From the above, it may be stated that the germination-regulation mechanism in case of *Scirpus articulatus* is related to temperature, conforming to the category of "built-in temperature gauge". The seeds of this plant are able to distinguish between unchanging constant temperatures and the temperatures which alternate between cold and warm. Seeds that regulate their germination in response to such environmental signals may be able to prevent germination in micro-environments or unfavourable seasons. Compared to alternating temperatures, light or chemical treatments do not seem to have much impact on breaking the dormancy of these seeds.

Conclusions

An investigation has been taken up to study the seed and germination of *Scirpus articulatus*.

The seeds are minute and the mean dimension includes: length, 1.48 mm; breadth 1.015 mm; mean volume, 0.001 ml and mean weight, 0.005 gm.

The seeds possess dormancy. Only about 1.0 per cent germinates immediately after collection from the plant and the rate increases to 35 per cent after storage at laboratory temperature for 16 weeks.

Various physical and chemical treatments are given and the percentage of germination noted. The exposure of seed to constant temperatures of 5, 26, 30 and 37° C reduces the rate of germination to the minimum. On the other hand, chilling the seeds at a low temperature for one week and then transferring to a higher temperature improves germination by as much as 77.8 per cent. If seeds are exposed to continuous darkness, no germination is shown. The diffused light raises the rate to 4.0 per cent and continuous light to 33 per cent. The seeds treated with solutions of NaCl and $MnSO_4$ indicate generally low percentage of germination compared to the corresponding controls. However, the rate is slightly increased over that of the controls when soaked in the solutions of KNO_3, NH_4NO_3 and thiourea.

Acknowledgement

We wish to express our grateful thanks to Prof. S. M. Sircar, Head of the Department of Botany, Calcutta University, for providing us with necessary facilities for the work.

REFERENCES

Datta, S. C. (1961a): Germination Studies on the Seeds of Two Desert Plants. Ind. Agricult. **5,** 111—112.

Datta, S. C. (1961b): Studies of Oleander Seed Germination. Bull. Coll. Sci., Baghdad. **6,** 71—79.

Datta, S. C.—Chakravarti, H. L. (1962): Germination Studies on the Seeds of *Citrullus*. Ind. Agricult. **6,** 220—222.

Sankar, V. (1965): Germination of the Seeds of *Trichodesma amplexicaule* Roth. Proc. 53rd Ind. Sc. Cong., Part III (Abst.), 315.

Subramanyam, K. (1962): Aquatic Angiosperms. C. S. I. R., New Delhi.

Toor, P. S. (1964a): Effect of some Physical and Chemical Treatments on the Germination of *Indigofera enneaphylla* Linn. Proc. Comb. 51st & 52nd Ind. Sc. Cong., Part III (Abst.), 383.

Toor, P. S. (1964b): Studies in the Seed and Germination of *Gomphrena celosioides* Mart. Proc. Comb. 51st & 52nd Ind. Sc. Cong., Part III (Abst.), 384.

Went, F. W. (1948): Ecology of Desert Plants. I. Observations on Germination in the Joshua Tree National Monument. Ecology. **29,** 242—253.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 359—372 (1968)

FORMATION OF VOLATILE OIL DUCTS IN THE DEVELOPING PISTIL OF HERACLEUM MANTEGAZZIANUM SOMM. ET LEV.

By

A. Kovács, S. Sárkány

DEPARTMENT OF APPLIED BOTANY AND HISTOGENESIS OF THE L. EÖTVÖS UNIVERSITY, BUDAPEST

As far as differentiation and localization are concerned, the pistil of the *Heracleum* species examined has two different volatile oil excreting systems. Certain ducts develop near the vascular bundles and follow their direction, while others (the own volatile oil containers of the pistil wall) are sited at some distance from the vascular bundles and end blindly. The initial development of both types is marked by inequal divisions. The organization of the ducts accompanying the vascular bundles coincides with the differentiation process of the procambial system, whereas the development of the pistil's own volatile oil containers begins in various phases of pistil development. In the ovary wall the primordia of epithelial cells of the successive ducts are readily recognizable in the plication phase of pistil organization, while the beginning differentiation of the four ducts in the septum cannot be observed but after the end of the plication phase. Vertical and horizontal growth can be ascribed to the division of the young epithelial cells by means of anticlinal and transversal walls. Due to the difference in the rhythm and duration of division, the number of cells in the epithelium layer (in cross section) will be, at fully developed age, ten times higher in the own volatile oil ducts of the pistil than it was initially, while in the ducts next to the bundles it will be only three or four times higher.

Introduction

Microscopic examinations performed in the 19th century on different vegetable organs included among others the excretory system as well (Meyen 1837, Dippel 1863, van Tieghem 1872, De Bary 1877, Meyer 1889, Tschirch 1893—1900). In the 20th century, due to the steadily improving instruments and methods, cytohistological research work was continued in this sense at a much larger scale (Tschirch 1906, Leemann 1926, Guttenberg 1928, Elias 1929, Hannig 1930, Esau 1940, Bruch 1955; etc.) and was practically extended to the chemical analysis and histo-chemical aspects of the components of excretions, too (Tunmann—Rosenthaler 1931, Frey-Wissling 1935, Kisser 1958, etc.).

In the plants excreting or secreting different substances, the cells and tissues accomplishing the excretory function are known to display (even within the family) a most variable form of appearance and often a specific structure, too. Concerning the fully developed organs the anatomical characteristics of the excretory system are fairly well known and interpreted similarly (e.g. for the *Coniferae:* Gauba 1926, Tschirch 1893, for the *Umbelliferae:* Elias 1929, Esau 1940, Bruch 1955). On the other hand, there are often contradictory statements to be found in technical literature on the conditions of development even within the same unit of relationship (family, genus, species): The more are there when the organization of schizogene and lysigene ducts are described (GUTTENBERG 1928, ELIAS 1929, ESAU 1940, KAUSSMANN 1963). Since we had earlier examined the question of pistil organization within the *Umbelliferae* family and confirmed for several species the appendicular nature of the pistil wall (KOVÁCS—SÁRKÁNY 1968), it was obvious to extend our examinations to the histogenetical analysis of the schizogene volatile oil ducts of the pistil and of the fruit. In this respect we have found no data in literature. Among the species examined, the present paper will follow the conditions of development of volatile oil ducts of *Heracleum mantegazzianum* up to the stage of the ripe pistil.

Material and Method

Inflorescences of various stages of development were gathered in two successive years (1964, 1965) in the demonstration garden of the Botanical Research Institute in Vácrátót. The flower primordia and fullblown flowers of different age were fixed for 2—4 hours in Bouin's fixing solution and kept in 70 per cent alcohol after delution.

In the course of microtechnical operations, the paraffin embedding method was applied. Serial sections of 12—15 μ thickness were prepared with Reichert-type slide microtome, by means of plano-convex microtome cutter. The sections were stained with vesuvine and covered in Canadian balsam.

In order to examine volatile oil contents excreted into the ducts, hand-made sections of newly gathered flowers were used.

Results

Interpreted from ontogenetical point of view, the gynaeceum of *Heracleum* has two different primary volatile oil excretory systems which are topographically sited also in two different ways (Fig. 1., m, s, sz, si, i). As to one of the localization forms the ducts follow the course of the vascular bundles in the immediate neighbourhood of the phloem's external part. The other form of localization makes up the totality of the volatile oil containers, readily discernible in the mesophyll of the pistil wall and the partition and surrounded with parenchyma from between the vascular bundles; these containers are next to the internal epidermis delimiting the two ovary caves, and end blindly.

The development of the different volatile oil ducts begins at various times during the development of the gynaeceum. In the plication phase of the organization of the gynaeceum, when the ovary cave is divided only in the lower zone by the septum produced by curled up leaf edges and when, in the upper zone, the carpels do not yet touch each other, the procambial bundles of the ovary wall are already accompanied by a young duct surrounded by four or five epithelial cells. At the same time, in the meristematic parenchyma of the ovary wall, there are dividing cell groups in the fourth or fifth row reckon-

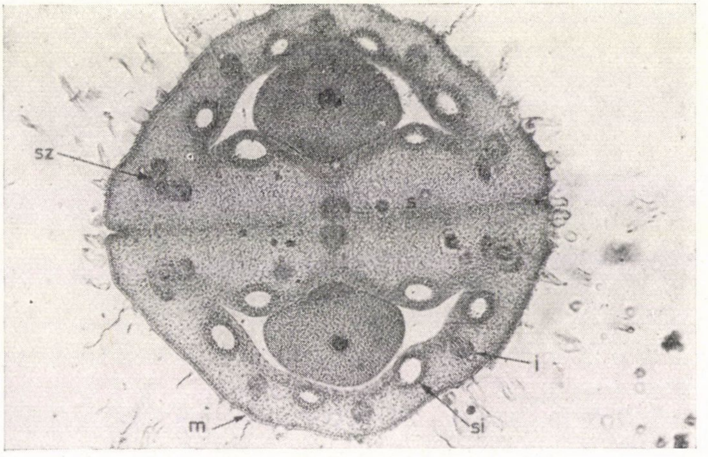


Fig. 1. Cross section of ovary in fully developed flower with two ovules; ovary wall (m), septum (s), vascular bundles (sz), own volatile oil ducts of gynaeceum (si), volatile oil ducts running near the vascular bundles (i). Oc.: 6.3 Obj.: 6.3

ed from the internal protoderm, indicating the beginning of organization of further ducts. In the septum the intial development of volatile oil ducts cannot be observed but after the end of the plication phase. The successive organization of the volatile oil ducts is correlated to the differentiation process of the meristematic zones of the gynaeceum, as it is the external part of the ovary wall that is first differentiated and stabilized, then follows the internal part and, at last, the septum.

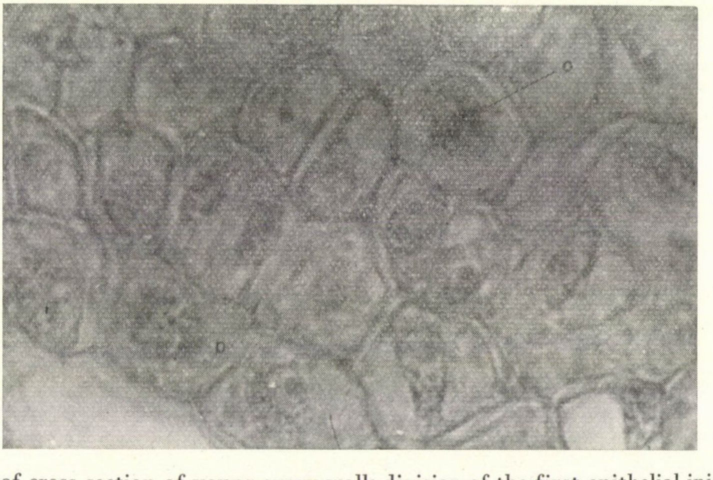


Fig. 2. Part of cross section of young ovary wall; division of the first epithelial initial mother-cell (o), internal protoderm (p). Oc.: 6.3 Obj.: 90

Studying adequate cross sections, we have found the following sequence of development in the organization of the ducts limited in the ovary wall and in the septum by parenchyma, i.e. in the proper volatile oil containers of the gynaeceum:

The beginning of their formation is initiated by the successive inequal division of three or occasionally four cells. In the fourth or fifth cell row reckoned from the internal protoderm of the ovary wall, one of the cells of the meristematic parenchyma between two bundles distinguishes itself by the vigorous division of its nucleus (Fig. 2, o, p). Then the nucleus of one of the adjacent cells begins also to divide and almost simultaneously two new cell

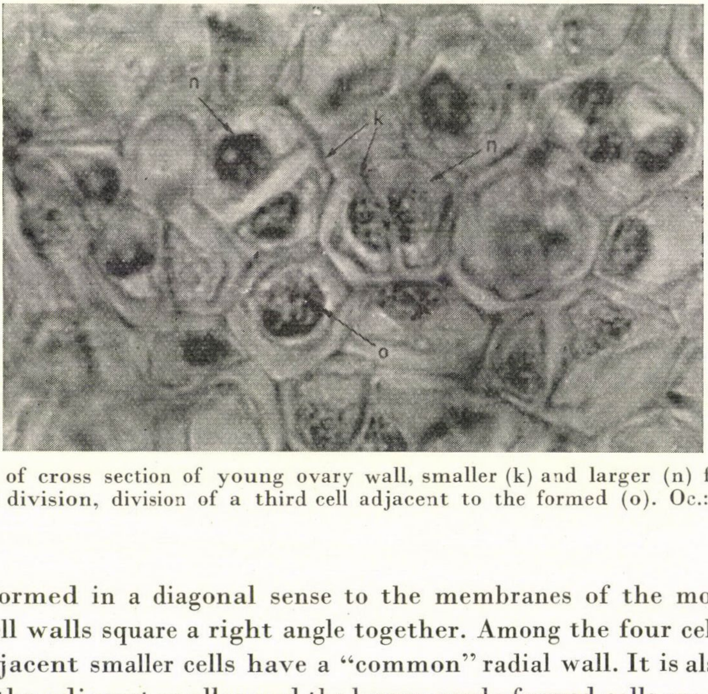


Fig. 3. Part of cross section of young ovary wall, smaller (k) and larger (n) formed cells after inequal division, division of a third cell adjacent to the formed (o). Oc.: 6.3 Obj: 90

walls are formed in a diagonal sense to the membranes of the mother cells. The new cell walls square a right angle together. Among the four cells formed, the two adjacent smaller cells have a "common" radial wall. It is also remarkable that the adjacent smaller and the larger newly formed cells are the mirror images of one another (Fig. 3, k, n). Initial division of the nucleus of the third meristematic cell adjacent to the two smaller cells can also be observed (Fig. 3, o). The developing cell wall divides the mother cell into a smaller and a larger cell, so this division is also an inequal one (Fig. 4). The adjacent smaller newly formed cells (Fig. 4), marked with an arrow (Fig. 5,a), may be regarded as the primordia of the epithelial cells delimiting the future schizogene cavity. On the cross section they are of triangular shape.

The larger sister-cells of the epithelial primordia are either gradually stabilized into parenchymatic basic tissue elements, or one or the other of them

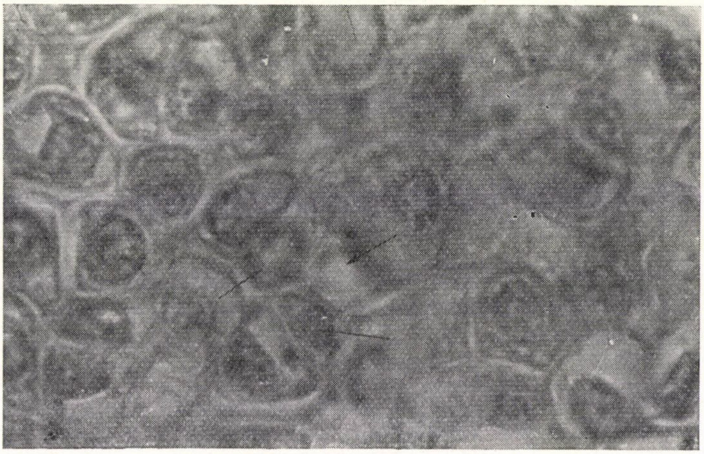


Fig. 4. Part of cross section of young ovary wall; cells of epithelial initial (arrow). Oc.: 6.3 Obj.: 90

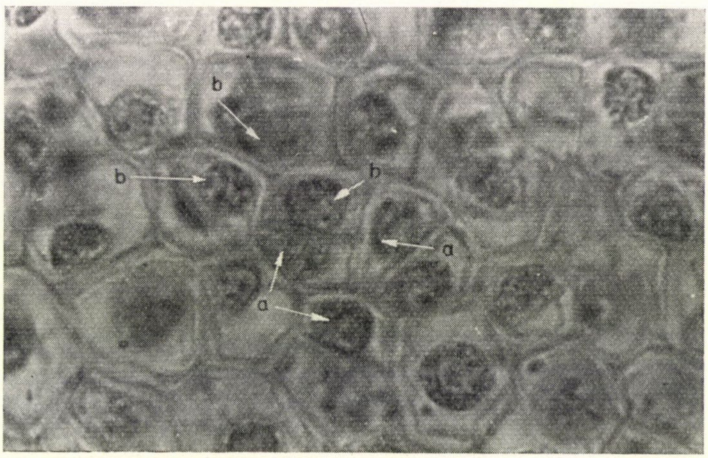


Fig. 5. Part of cross section of young ovary wall; 3 + 3 initial cells of the epithelial layer. Oc.: 6.3 Obj.: 90

takes part in the development of further volatile oil ducts together with some of the adjacent and inequally divided cells (Fig. 5, b). Twin ducts are formed in this way.

The young epithelial cells elongate in tangential sense and are divided by anticlinal walls, delimiting in this way the steadily growing schizogene ducts (Fig. 6, e, ü). Subsequently the number of epithelial cells is multiplied with further divisions made by anticlinal walls to eight or ten times the original number. This process runs in parallel to the horizontal (Fig. 7, e) and vertical

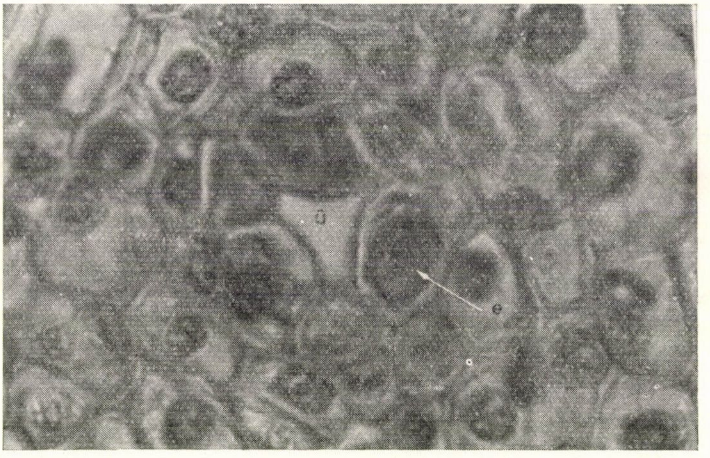


Fig. 6. Part of cross section of young ovary wall; volatile oil duct, larger epithelial cells (e), schizogene cavity (ü). Oc.: 6.3, Obj.: 90

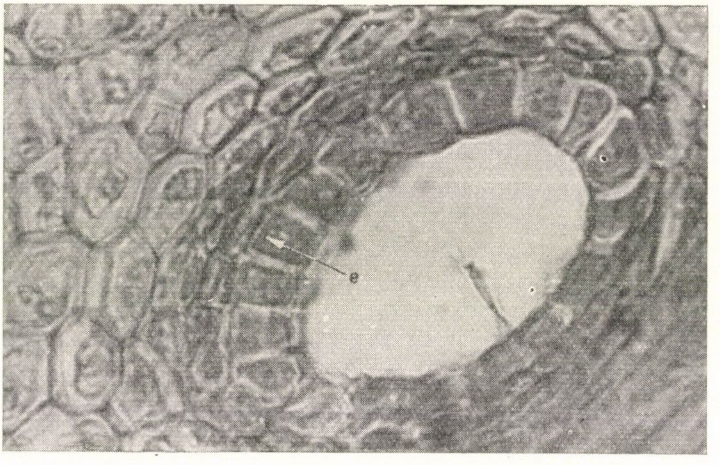


Fig. 7. Part of cross section of young ovary; increased volatile oil duct, single-row epithelial layer produced by divisions with anticlinal walls (e). Oc.: 6.3. Obj.: 40

(Fig. 8, i) growth of the ducts. Meanwhile, though somewhat later, begins in the septum the initial organization of the four schizogene ducts, in the way described above. In the epithelial cells the divisions by anticlinal walls are accompanied by changes in the shape of the cells; at last, they assume a quadrangular shape in cross section, while their tangential wall adjacent to the cavity protrudes slightly towards the cavity (Fig. 7); as compared with the parenchyma cells of the surrounding basic tissue, their plasm gets intensely stained; they remain rich in plasm until their function is accomplished; their

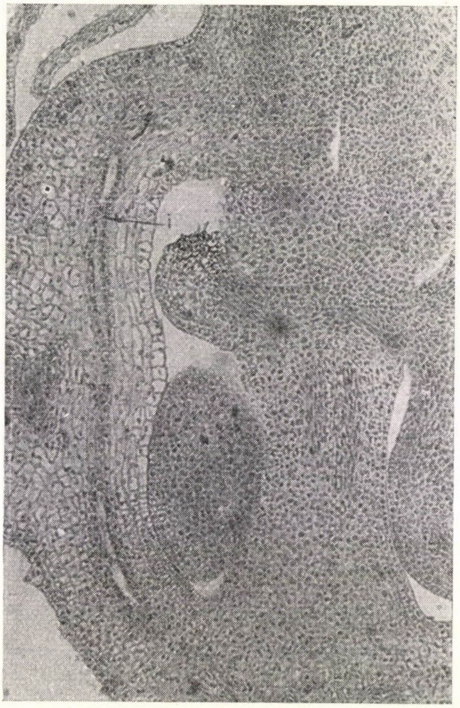


Fig. 8. Part of longitudinal section of developing ovary; volatile oil ducts of the ovary (i). Oc.: 6.3. Obj.: 16

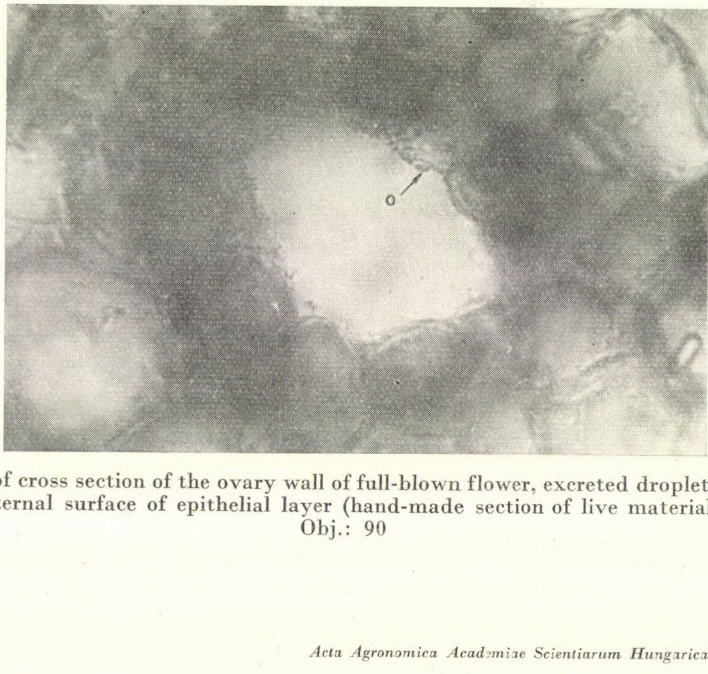


Fig. 9. Part of cross section of the ovary wall of full-blown flower, excreted droplets of volatile oil (o) on internal surface of epithelial layer (hand-made section of live material). Oc.: 6.3. Obj.: 90

slightly oval nucleus has increased. In its colloidal state the volatile oil excreted by the plasm appears on the cell walls adjacent to the cavity, in adjoining drop rows (Fig. 9. o); once the drops are increased in number, the rows get into the cavity in the shape of twisted chains (Fig. 10. o) where they are being accumulated and resinified (Fig. 11. j). The cells of the parenchymatic basic tissue delimiting the epithelial layer of the ducts follow the diametrical growth of the volatile oil containers with dilatation, while being divided by periclinal walls (Fig. 7).

The organization of the volatile oil ducts developing next to the vascular bundles practically coincides with the differentiation process of the vascular system originating from the procambium. The formation of these ducts is

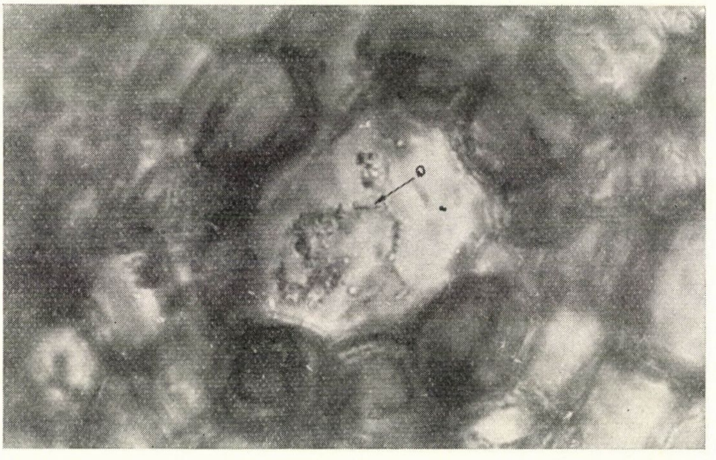


Fig. 10. Part of cross section of the ovary wall of full-blown flower; specific arrangement of volatile oil drops in schizogene duct (hand-made section of live material). Oc.: 6.3. Obj.: 90

usually initiated only by the inequal division of two adjacent cells, so that after the new cell walls have appeared the four newly formed cells continue to function as epithelial cell primordia. The two smaller newly formed cells are turned towards the external surface of the gynaeceum wall and the two larger ones towards the phloem part of the forwarding bundle. The skew walls square a right angle with the radial wall. The adjoining sides of the epithelial cell primordia get detached, forming thus a schizogene duct (Fig. 12, i) then they continue to be divided by anticlinal walls. In a sexually mature flower the diameter of these ducts (in cross section) is at least four or five times smaller than that of the gynaeceum's own volatile oil containers, being given the fact that the number of cell divisions is greatly inferior. On the other hand, the longitudinal growth of cells (division) follows the longitudinal growth of the gynaeceum.

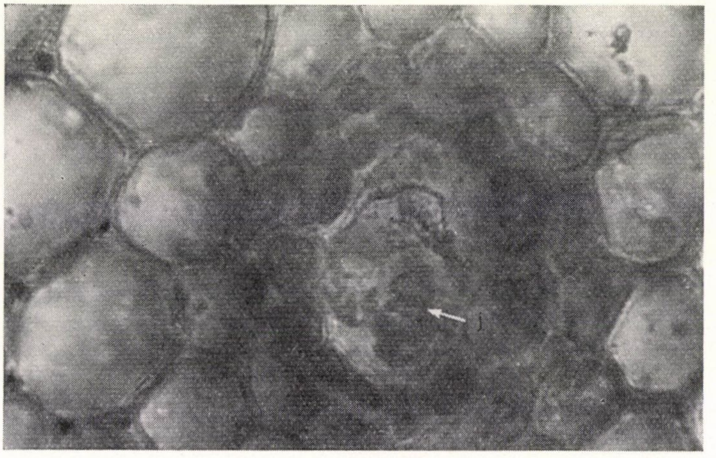


Fig. 11. Part of cross section of the ovary wall of full-blown flower; schizogene duct with resinifying excretion (j) (hand-made section of live material). Oc.: 6.3. Obj.: 90

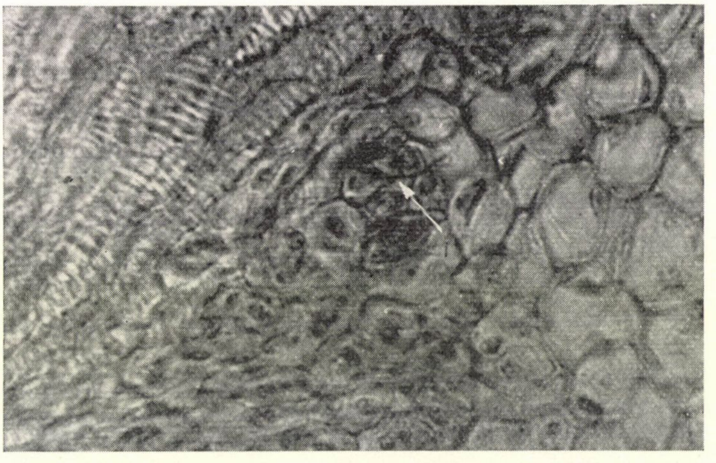


Fig. 12. Part of longitudinal section of young ovary wall; young volatile oil duct (i) with four epithelial cells. Oc.: 6.3 Obj.: 40

Organized at different moments and reveted by an epithelium layer of a single cell row, the volatile oil ducts taking place in the gynaeceum of the mature flower can be regarded as fully developed ducts. The oldest and longest volatile oil ducts, comparatively narrow in diameter, run along the vascular bundles. They partly proceed upwards to the tip of the stigma where they end tapered and blindly, and partly continue downwards in the ovary wall; six out of ten volatile oil ducts end also blindly in different zones of height, while four get through the basis and pass over into the peduncle of the flower where they can be seen next to the four vascular bundles characteristic of the flower axis; no anastomosis of these ducts has been observed.

Eight of the gynaeceum's own volatile oil ducts can be observed in the ovary wall and four in the septum. In the form of a slightly S-shaped or a flattened cylinder they are sited in the peripheral mesophyll and in the partition of the ovary as well as in the discus of the gynaeceum. The gynaeceum's own volatile oil ducts are different in length (Fig. 13), which is correlated to the chronological sequence of organization. The longest are those four (2 + 2) volatile oil ducts which are sited in the protruding part of the ovary wall,

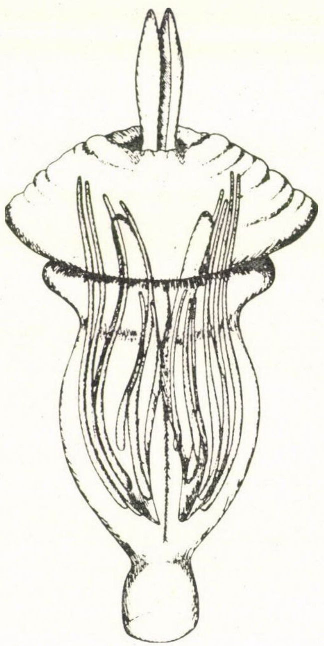


Fig. 13. Sketch plan of the own volatile oil ducts of the gynaeceum of a full-blown flower. Linear magnification: 15 : 1

between the three central collateral vascular bundles, reaching from the lower level of the ovary cave to two thirds of the apical region of the discus. Somewhat shorter are those four (2 + 2) oil ducts, which are nearer to the bicollateral bundles; they reach from the initial swelling of the ovary to the midlevel of the discus. The shortest — and those organized the last of all — are the flattened cylindrical ducts of the partition, beginning at the lower third of the ovary cave and ending near the zone below the separation level of the stamina and petals. The gynaeceum's own volatile oil ducts get gradually tapered on both ends, their diameter and cavity get ever narrower and at the same time the number of epithelial cells also decreases (Fig. 14, i). At the end of the ducts there are only adjoining epithelial cells arranged in circular form which indicate the beginning and the end of the ducts (Fig. 15,e).

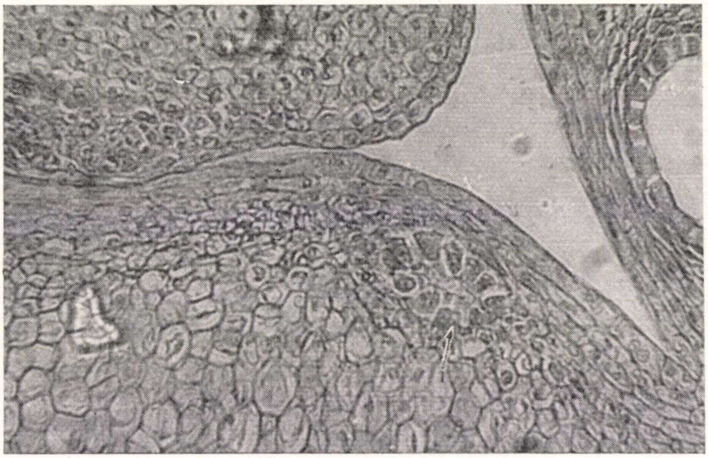


Fig. 14. Part of cross section of developing ovary; own volatile oil duct with tapering cavity (i) in the septum. Oc.: 6.3. Obj.: 16

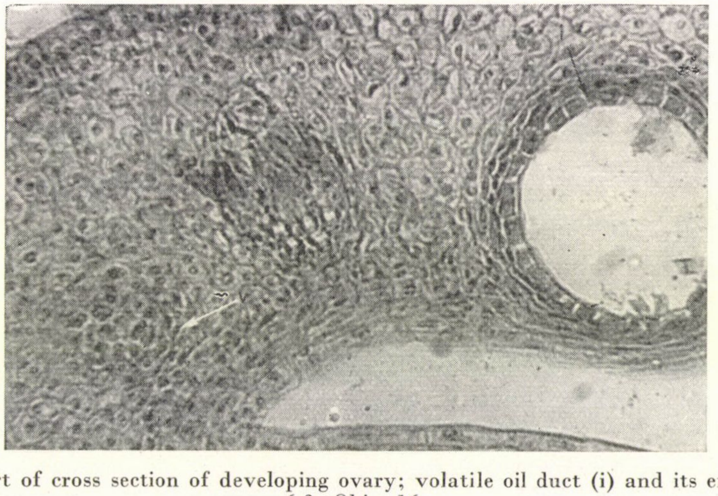


Fig. 15. Part of cross section of developing ovary; volatile oil duct (i) and its end (v). Oc.: 6.3. Obj.: 16

Conclusions

There are no detailed data in literature about the course of development of schizogene volatile oil ducts developing in the gynaeceum of the *Umbelliferae*, including *Heracleum mantegazzianum*, while there are some data about the vegetative organs. We have conducted informative investigations on vegetative organs (root, stem, leaf stalk) of several species (*Foeniculum vulgare, Heracleum mantegazzianum, Silaum silaus* L. Schinz. et Thell., *Seseli* *libanotis* Koch ssp. *sibiricum*), as well as on young leaves and stems of some species of other families and have been led to the conclusion that the organization of volatile oil ducts in these organs is the same as in the gynaeceum. Our results are going to be compared with literary data referring to vegetative organs of species belonging to different families.

Relying upon our examinations we have found that inequal divisions take place at the initial development of the volatile oil ducts of the gynaeceum of *Heracleum*. Separated by diagonal walls, the newly formed cells either take part in full in the formation of the epithelial lining (e.g. in the excretion ducts running along the bundles), or the adjoining smaller cells are functioning, if there are more than two cells divided inequally (in the gynaeceum's own volatile oil ducts). Our results agree with those of ESAU and BRUCH. Dealing with the histogenesis of the fleshy storing organ of *Daucus carota*, ESAU (1940) has observed divisions made by skew walls; the newly formed cells have developed ducts delimited by schizogene cavities. In studying the histogenesis of the root of *Foeniculum vulgare*, BRUCH (1955) has discovered similar divisions in the pericycle, initiating the subsequent development of volatile oil ducts. Although these authors do not mention inequal divisions, the description of the development process and their illustrations display results comparable to our own findings. The histogenetical studies and illustrations published by LEE (1952) on the leaves of *Dacrydium taxoides* reflect an order of development in agreement with our findings.

According to GOEBEL and SANDT (1930) the duct initials are developing through the withdrawal of some cells from one another. In opposition to our own observations and to the above-cited references, this finding is probably due to the fact that the stages of development immediately preceding the formation of the cavity failed to be detected. ELIAS (1929) has never seen duct initials in the germinal roots of the *Umbelliferae* prior to the procambial appearance of the vascular bundles. In our investigations on the gynaeceum of *Heracleum* we have generally found the same. On the other hand, the above named author has observed tangential divisions in the early stage of the volatile oil ducts, a finding we are unable to confirm. In the course of our informative investigations we have studied not only the young gynaeceum but also the root of the species that he had observed *(Levisticum officinale)*, and we have found an organization comparable to that of the gynaeceum of *Heracleum*. Speaking about the development of excretory ducts, GUTTENBERG (1928) and KAUSSMANN (1963) refer, at the beginning, to radial divisions. We have also observed radial divisions in the initial cells of the epithelium layer, but only after the inequal divisions.

The growth of ducts in the gynaeceum of *Heracleum* is accompanied by divisions of the epithelial cells made by anticlinal walls. In studying some species of the *Umbelliferae*, ELIAS (1929) has observed similar phenomena.

In agreement with the observations of POHL on *Philodendron* (1932) and of BRUCH (1955) we have not found the anastomosis of the volatile oil ducts in the gynaeceum of *Heracleum* either; at the same time, ESAU (1940) reports on the anastomoses occurring in the storage organ of *Daucus carota.*

Our observations on the "granulated" cytoplasm of the epithelial cells and on their enlarged nuclei confirm the results of PIRSCHLE (1926) extending to several species of the *Umbelliferae*, where, in 94 per cent of the cases, similar conditions were found. STAHL (1957) explains the enlarged nucleus of the glandular hairs of the *Achillea* with the occurrence of endomitosis, on account of which the nuclei become polyploid. We have also observed the presence of enlarged nuclei, but failed so far to recognize with absolute certainty any phenomena referring to polyploidy.

We attach a great importance to elucidate the spatial arrangement of gynaeceum's own volatile oil containers, as no exact data have been found in this domain. Publications appeared so far (SÁRKÁNY 1962, KARSTEN—WEBER 1949) are rather of exploratory character.

REFERENCES

BARY, A. DE (1877): Vergleichende Anatomie der Vegetationsorgane. Leipzig.

BRUCH, H. (1955): Beiträge zur Morphologie und Entwicklungsgeschichte der Fenchelwurzel. Beitr. Pflanz., **32,** 1—26.

DIPPEL, L. (1863): Zur Histologie der Coniferen. Botan. Ztg.

ELIAS, S. (1929): Die Entwicklung der Sekretbehälter mit besonderer Berücksichtigung der Sekretbildung- und -ausscheidung bei einzelnen Arten der Umbelliferen und Rutaceen. Diss. Berlin.

ESAU, K. (1940): Developmental Anatomy of the Fleshy Storage Organ of *Daucus carota.* Hilgardia, **13,** 175—209.

FREY-WISSLING, A. (1935): Die Stoffausscheidung der höheren Pflanze. Berlin.

GOEBEL, K.—SANDT, W. (1930): Untersuchungen an Luftwurzeln, Goebel. Bot. Abh., **11,** 17. Jena.

GAUBA, E. (1926): Beiträge zur biologischen Anatomie des Koniferenblattes. Biol. generalis (Wien), **2,** 301—337.

GUTTENBERG, H. v. (1928): Die Harzdrüsen von *Lysimachia vulgaris* L. Planta (Berl.), **5,** 232—238.

HANNIG, E. (1922): Untersuchungen über die Harzbildung in Coniferennadeln. Zeitschr. f. Bot., **14,** 358—421.

KARSTEN, G.—WEBER, U. (1949): Lehrbuch der Pharmakognosie. 7. Aufl. Jena.

KAUSSMANN, B. (1963): Pflanzenanatomie. Jena.

KISSER, J. G. (1958): Die Ausscheidung von ätherischen Ölen und Harzen. In W. Ruhlands Pflanzenphysiologie. Bd. X. 91—129. Berlin—Göttingen—Heidelberg.

KOVÁCS, A.—SÁRKÁNY, S. (1968): Néhány megfigyelés a *Heracleum mantegazzianum* Somm. et Lev. termőszerveződésével összefüggésben. Acta Agron. Acad. Sci. Hung., **17.** 47—59.

LEE, C. L. (1952): The Anatomy and Ontogeny of the Leaf of *Dacrydium taxoides.* Am. Jour. of Bot., **39,** 393.

LEEMANN, A. (1926): La théorie de Tschirch et le développement des cellules sécrétrices. C. r. Soc. Physique et Hist. natur., Genève, **43,** 88—92.

MEYEN, F. J. F. (1837): Über die Sekretionsorgane. Berlin.

MEYER, A. (1889): Über Entstehung der Scheidewände in dem sekretführenden plasmafreien Interzellularraum der Vittae der Umbelliferen.

PIRSCHLE, K. (1926): Zur Lage der Zellkerne in den Sekretkanälen der Umbelliferen. Öst. Bot. Zeitschr., **76.**

POHL, FR. (1932): Anatomische und ökologische Untersuchungen am Blütenstande von *Philodendron Selloum* Schot. mit besonderer Berücksichtigung der Harzkanäle und der Beschaffenheit der Pollenkittstoffe. Planta (Berl.), **15**, 506—529.

SÁRKÁNY, S. (1962): Organisation des Stempels und der Spaltfrucht von *Foeniculum vulgare* Mill. und die Frage des sogenannten unterständigen Fruchtknotens. An. Univ. Sci. Budapestiensis, Sect. Biol., **5**, 193—224.

STAHL, E. (1957): Über die Vorgänge in den Drüsenhaaren der Schafgarbe. Zeitschr. für Bot., **45**, 297—315.

TSCHIRCH, A. (1893): Über Bildung von Harzen und äth. Ölen im Pflanzenkörper. Jahrb. wiss. Bot., **25**, 370—379.

TSCHIRCH, A. (1893): Über den Ort der Öl- bzw. Harzbildung bei den schisogenen Sekretbehältern. Dtsch. Bot. Ges., **11**,

TSCHIRCH, A. (1900): Die Einwände der Frau Schwabach gegen meine Theorie der Harzbildung. (Zit. Elias 1929).

TSCHIRCH, A. (1906): Die Harze und die Harzbehälter mit Einschluss der Milchsäfte. 2. Aufl. Band I. u. II. Leipzig.

TUNMANN, O.—ROSENTHALER, L. (1931): Pflanzenmikrochemie. 2. Aufl. Berlin.

VAN TIEGHEM, P. (1872): Mémoires sur les canaux sécréteurs des plantes. Ann. d. Sci. Nat. Bot., V.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 373—379 (1968)

CORN YIELD AS INFLUENCED BY THE DATE AND METHOD OF NITROGEN FERTILIZER APPLICATION

By

I. I'só, T. A. Hussien

AGRICULTURAL RESEARCH INSTITUTE OF THE HUNGARIAN ACADEMY OF SCIENCES, MARTONVÁSÁR

The method and date of adding the nitrogen as fertilizer has been studied by a number of investigators. The results presented in this paper show the corn yield and height of the plants as influenced by date and method of nitrogen fertilizer application. In the two experimental years 1965 and 1966 grain yield was significantly influ enced by early application of nitrogen broadcasting or banding before or after planting date Leaf spraying with ammonium nitrate decreased significantly the grain yield during the two experimental years.

Introduction

The rate of plant growth and grain yield in corn plants is highly affected by differences in soil fertility. The pattern of growth and nutrient uptake by corn plants as influenced by the method and date of adding nitrogen as fertilizer has been studied by a number of investigators. Cantar—Vasilica (1959) reported that adding nitrogen as top dressing increased the grain yield especially in the rainy years. Birecki—Rudkiewicz (1963) found that adding compound fertilizer as top dressing increased both the grain and green yield especially in rainy years.

The experiments of Győrffy—Szalay (1962) showed that yield of corn plants was not significantly influenced by the date of nitrogen fertilizer application. However, significant difference was obtained when the ammonium sulphate was added in autumn and the ammonium nitrate in the spring.

The same investigators in another experiment concluded from the results of 5 years' experiments that no increase in the grain yield was obtained depending on the differences in the method and date of adding nitrogen fertilizer, however, protein rate was increased in the stalks.

Davidescu—Vines (1964) estimated that the date of nitrogen fertilizer application had not any effect on the grain yield. Pavlov (1963) found that leaf spraying with carbamide increased the rate of sugar and amino nitrogen in the leaf and — on the other hand — decreased the total nitrogen and protein rate. Daujat (1962) found a relation between leaf spraying with nitrogen in corn and the date of spraying. Thinning date, hoeing date were the best two dates for spraying.

Material and Methods

Our experiments were established in the experimental field of the Agricultural Research Institute in Martonvásár during the seasons of 1965 and 1966. The object of this investigation was to study the effect of date and method of nitrogen application as fertilizer on corn yield.

The type of the experimental field soil was grassland loam which had previously been planted with corn in both seasons. The most important agricultural treatments in both experimental years are listed in Table 1. In April 1965 soil samples were taken for chemical test, the same was done in 1966. The soil test results are given in Table 2.

Table 1

The times of the most important agricultural treatments

	1965	1966
1 Autumn deep ploughing	XI. 26. 1964	XI. 19. 1965
2 Spring smoothing	III. 17. 1965	IV. 8. 1966
3 Preceding crop	hybrid corn Mv 40	hybrid corn Mv 40
4 Discing and harrowing	III. 17. 1965	IV. 12. 1966
5 Fertilizer broadcasted before planting	V. 8.	V. 6.
6 Planting date	V. 8.	V. 6.
7 Emergence date	V. 19.	V. 16.
8 Herbicide spraying	—	V. 6.
9 Hoeing date	V. 25., VI. 21.	VI. 13.
10 Fertilizer top dressing	VII. 1.	VI. 15.
11 Fertilizer and water leaf spraying	VII. 27—VIII. 3.	VII. 21—VII. 26.
12 Date of harvesting	X. 13.	IX. 23.

Table 2

Soil test values Martonvásár, 1965—1966

Year	Depth cm	pH		Total humus %	Total nitrogen %	Total P_2O_5 %	Total K_2O %
		water	KCl				
1965	0— 25	7.47	7.15	2.42	0.15	0.14	0.67
	25— 50	7.47	7.15	1.86	0.13	0.81	0.61
	50—100	7.60	7.45	0.79	0.055	0.51	0.64
	100—120	7.41	7.65	0.20	0.022	0.08	0.65
1966	0— 25	7.00	7.20	3.63	0.21	0.04	0.29
	25— 50	7.20	7.20	3.17	0.19	0.04	0.38
	50—100	7.30	7.70	1.42	0.08	0.03	0.20
	100—120	7.70	7.80	0.40	0.03	0.02	0.24

The following treatments were included:

1) No fertilizer,
2) N fertilizer broadcasted before planting,
3) N fertilizer banded near the rows after planting,
4) N fertilizer broadcasted when the height of the plant was 20 cm,
5) N fertilizer banded when the height of the plant was 20 cm,
6) Leaf spraying with ammonium nitrate 1 per cent solution,
7) Leaf spraying with carbamide 1 per cent solution
8) Leaf spraying with water.

The leaf spraying was done by back-sprayer 5 times, every time 5 litres of water were used.

Variety: Martonvásár 40 hybrid (early).

In 1965 latin oblong design was used. Each whole plot of 25 m^2 consisted of 10 rows 10 meters long. Each treatment was replicated 4 times. The same was done in 1966 in randomized block design. The corn was planted in 50 cm rows at a plant distance of 50 cm with corn planter by hand.

Three seeds were cropped per hill. At five leaf stadium the stand was thinned to one plant per hill. Nitrogen fertilizer was used, 100 kg active agent per hectare. From the second treatment until the sixth treatment ammonium nitrate 25 per cent nitrogen active agent was used, but in the seventh treatment carbamide was used which contained 46 per cent nitrogen active agent. For the purpose of observations and measurements ten plants in each plot were chosen at random for the measurements of plant height. After the ripening, yield of each plot was weighed. To determine the yield, samples from the ears were taken and dried up to 15 per cent moisture account and from the results obtained the dry grain yield was calculated. The main meteorological data for the two years 1965—66 are presented in Table 3.

Results

Corn grain yield. Table 4 shows the corn yield as affected by the date and method of nitrogen application in the two experimental years 1965—66.

The effect of nitrogen on increasing the corn grain yield was easily detected. When the fertilizer was applied, i.e. broadcasted or banded before or after planting, grain yield was increased by 20—25 per cent in 1965 and 5—15 per cent in 1966 in comparison to the control. The broadcasting and banding of the nitrogen as top dressing when the plants reached 20 cm in height increased the grain yield by 5—10 per cent in 1965 and by 10—13 per cent in 1966.

The leaf spraying with ammonium nitrate decreased largely and significantly the grain yield in the two years experiments. The decrease was 25 and 11 per cent in 1965 and 1966, respectively. In 1965 leaf spraying with carbamide decreased the grain yield, but not significantly. However, it increased the grain yield significantly in 1966, In both seasons — naturally — the leaf spraying with water was not significantly different from the control.

Height of corn plants. Table 5 shows the height of corn plants in cm as influenced by the date and method of nitrogen fertilizer application in the two experimental years.

The height of the plants has increased significantly when using the nitrogen fertilizer broadcasted or banded at planting time and broadcasted when the plants reached 20 cm height in 1965. However, no increase was accomplished in 1966. Leaf spraying with ammonium nitrate has decreased the height

Table 3

Meteorological data
Martonvásár, 1965—1966

Designation	Winter half year X—III	Total per month average °C, mm						Growing period total mean mm, °C	Total per year mean °C mm
		IV	V	VI	VII	VIII	IX		
Precipitation data total mm									
1965	307	67	73	179	78	88	83	568	875
1966	326	49	59	53	159	87	10	417	743
Average (1901—1940)	243	46	66	62	50	52	52	328	571
Deviations from the average									
1965	+64	+21	+7	+117	+ 28	+36	+31	+240	+304
1966	+83	+ 3	−7	— 9	+109	+35	−42	+ 89	+172
Temperature °C									
1965	3.6	9.3	14.4	19.0	20.1	18.7	16.5	16.3	9.9
1966	4.2	13.3	17.2	20.4	21.0	20.4	16.8	18.2	11.2
Average (1901—1940)	3.1	10.1	15.9	19.1	21.5	20.7	15.7	17.1	10.1
Deviations from the average									
1965	+0.5	−0.8	−1.5	−0.1	−1.4	−2.0	+0.8	−0.8	−0.2
1966	+1.1	+3.2	+1.3	+1.3	−0.5	−0.3	+1.1	+1.1	+1.1

Table 4

Corn yield as affected by the date and method of nitrogen application
Martonvásár, 1965—1966

Treatments	Dry grain yield q/ha		Yield in relative numbers %	
	1965	1966	1965	1966
No fertilizer	57.42	52.8	100	100
N broadcasted before planting	71.60	55.2	125	105
N banded near the rows after planting	68.93	60.8	120	115
N broadcasted when the plant was 20 cm high	63.09	59.7	110	113
N banded near the rows when the plant was 20 cm high	60.14	58.0	105	110
Leaf spraying with ammonium nitrate	42.93	47.2	75	89
Leaf spraying with carbamide	55.19	58.1	96	110
Leaf spraying with water	58.68	51.4	102	97
Mean	59.74	55.4	104	104.87
L.S.D. 5% level	6.79	3.97	12	7.5

Table 5

Mean height of the plants in cm as influenced by the date and method of nitrogen application
1965—1966

Treatments	Mean height of the plants cm	
	1965	1966
No fertilizer	204.75	199.25
N fertilizer broadcasted before planting	217.00	201.25
N fertilizer banded near the rows after planting	217,00	195,75
N fertilizer broadcasted when the height of the plant was 20 cm	211.50	198.00
N fertilizer banded when the height of the plant was 20 cm	210.75	190.00
Leaf spraying with ammonium nitrate 1% solution	195.00	188.25
Leaf spraying with carbamide 1% solution	199.25	191.50
Leaf spraying with water	203.50	205.25
L.S.D. 5% level	6.42	11.77

of the plants significantly. However, leaf spraying with carbamide had no significant effect on the height of the plants in 1965. On the other hand, the two treatments had no significant effect on the plant height in 1966.

Conclusions

The results presented in this paper show the corn yield and height of the plants as influenced by the date and method of fertilizer application.

Corn grain yield. Generally grain yield in all treatments was larger in 1965 than in 1966. We can explain this by the meteorological data, as it is clear that the former year was a rainy one. This may suggest that grain yield is more influenced by the date and method of nitrogen application in rainy years. These results are similar to those obtained by CANTAR—VASILICA (1960), BIRECKI—RUDKIEWICZ (1963).

The grain yield of the second treatment in 1966 showed larger decrease than did the same treatment in 1965. However, this treatment produced the largest yield in 1965 in comparison with the other treatments. This might be due to the precipitation rate during the broadcasting period for the fertilizer. It was observed that rain is necessary when fertilizer is broadcasted before planting.

In the experimental years 1965 and 1966 grain yield was significantly influenced by early application of nitrogen broadcasting or banding before or after planting date. However, the grain yield increased significantly in the other two treatments broadcasted or banded when the plants reached 20 cm height. But not with the same rate of increase. This might be due to the fact that early application of nitrogen increases the vegetative growth and later increases the grain yield. Leaf spraying with ammonium nitrate decreased significantly the grain yield during the two experimental years. This might be due to the harmful effect of the spraying solution. It was observed that leaf blades were injured and burned on different places.

Therefore, it is not wise to use ammonium nitrate as leaf spraying solution for corn. Grain yield was not decreased significantly with carbamide application in 1965. However, the grain yield was increased significantly in 1966 with carbamide application. This might be due to the fact that the spraying date in 1966 was earlier than in 1965, and rain did not wash off fertilizer in 1966 as it did in 1965. It was observed from these results that using carbamide as leaf spraying solution in 1 per cent concentration had to be done before tasseling or during the tasseling period early in the morning or in the afternoon.

Plant height in cm. The height of the plants was increased significantly by an early application of fertilizer in 1965. In 1966 no significant increase was obtained. It is clear that the precipitation rate during the growing season in 1966 was smaller than in 1965. We think that is the reason why in 1966 the plants did not increase in height depending on the fertilizer application date.

The use of the ammonium nitrate as spraying solution decreased significantly the plant height in 1965. However, the use of the carbamide decreased the height but not significantly in 1965. A positive relation was found between the harmful effect of ammonium nitrate solution on the leaf blade and the decreasing in height.

REFERENCES

Birecki, M.—Rudkiewicz, F. (1963): Dokarmianie kukurydzy gnojówka i nawozami mineralnymi. Pamietnik Pulawski, **10**, 203—224.

Cantar, F.—Vasilica, C. *et al* (1959): Influenta ingrasamintelor de baza si suplimentare a supra productiei de Boabe la porumb, pe cernoziomul degradat de la ezareni — Lucrari stiintifce, Inst. Agr. Iasi, Fac. Agr. Zoot., Bucuresti. 133—143.

Daujat, A. (1962): La fertilization azöte L'engrais, Paris. **76**, 151. 14—16.

Davidescu, D.—Vines, I. (1962): Epoca de incorporare a ingrasamintelor cu azotla proumb pe solul brun-roscat de Moara Domneasca Lucrari Stiintifice, Inst. Agron. "N. Balcescu" Bucuresti. 6/A 79—83.

Győrffy, B.—Szalay, E. (1962): A kukorica nitrogén fejtrágyázásának vizsgálata (Nitrogen Top Dressing Experiment with Corn). Kukoricatermesztési kísérletek 1958—1960. (Corn Production Experiments 1958—1960). (Editor: I. I'só). Akadémiai Kiadó, Budapest. 112—114.

Győrffy, B.—Szalay, E. (1962): Nitrogén műtrágyák őszi alkalmazásának vizsgálata (Investigation of Nitrogen Fertilizer Application in Autumn). Kukoricatermesztési kísérletek 1958—1960. (Corn Production Experiments 1958—1960). (Ed. I. I'só). Akadémiai Kiadó, Budapest. 115—117.

Pavlov, A. N. — Павлов, А. Н. (1963): Некорневые подкормки кукурузы мочевиной с добавлением гибберелина. Физиол. раст. **5**, 556—560.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 381—388 (1968)

CHANGES IN THE AMINO ACID CONTENT OF DETACHED WILTING LEAVES OF SOLANUM LACINIATUM AIT. IN THE LIGHT AND IN THE DARK

By

G. PÁLFI

DEPARTMENT FOR PLANT PHYSIOLOGY, JÓZSEF ATTILA UNIVERSITY, SZEGED

In detached slowly wilting leaves the same amino acids have been found as in leaves fixed immediately after detachment, the ratios of the individual amino acids being, however, different. These differences, especially with regard to amides, have been very similar to those found in five other plant species infected with five different diseases. Wilting leaves have had in addition a distinctive feature, their proline content being twelve times as high as that of the control. Increased proline content is known to be characteristic of plants exposed to drought. Consequently the primary damaging factor acting on detached leaves is water deficiency. This hypothesis is supported by the fact that amino acid contents of detached leaves and of plants exposed to drought showed many similarities in some other respects too. In wilting leaves in addition to proline, phenylalanine has also accumulated. At the same time the level of leucine has displayed a characteristic decrease. The increased amount of proline was not due to protein breakdown but to de novo synthesis.

The highest amino acid content had been found in leaves wilting in the dark for five days. Subsequently there was a rapid drop of the amino acid content and by the time the leaves were completely desiccated the amino acid concentration of illuminated leaves exceeded that of the leaves kept in the dark.

Introduction

In detached leaves certain metabolic features are similar to those of intact attached leaves whereas some others are different. According to FARKAS *et al.* (1964) the metabolic pattern of detached leaves is in many ways similar to that of plant tissues attacked by parasites. There is, however, an additional factor with detached leaves: the regulatory effect of the roots ceases to operate in the shoots.

The purpose of our experiments was to study the changes in the amino acid composition of detached wilting leaves both in the dark and in the light. Since detached leaves do not die off immediately, some alterations in their amino acid metabolism can be expected. Data on total amino acid contents do not permit to draw any serious conclusions since amino acid accumulation may be due to high nitrogen supply, disease, high salt content of the soil, phosphorus deficiency and several other factors (PÁLFI 1964, 1965a, 1965b). Therefore the amino acids have been individually characterized, and correlations established between characteristic changes in their concentrations and the wilting process. At the same time extracts of detached wilting leaves have been compared to those of leaves showing characteristic disease symptoms.

Materials and Methods

Leaf samples were taken from the top of shoots bearing fully developed flowers. Part of the leaves were fixed immediately at 65° C and dried. The untreated leaves were divided into two groups. One group was subjected in an expanded state to an illumination of 2000 lux for 10 hours a day, whereas the other group was kept in the dark at the same temperature (25° C) and relative air humidity (60 per cent).

During the first five days the wilting leaf material was sampled and fixed every 12 hours, during the subsequent 10 days sampling and fixing was carried out every day. The leaf samples were homogenized with sea sand in 50 per cent methanol. The extract was centrifuged and the supernatant fluid subjected to one and two dimensional paper and thin layer chromatography. The solvents were butanol — glacial acetic acid — water (2 : 1 : 1) and phenol — ethanol — water (2 : 1 : 1). For identification ninhydrin, isatin and the so called "universal standard mixture" as described by PÁLFI *et al* (1966) and SZALAI (1957) were used. For quantitative estimations the spots fixed with Cu-salts and with proline the spots giving a blue colour with isatin were eluted. The protein was hydrolyzed with 6 *N* HCl at 105° C.

Results

First those illuminated leaves were investigated that had been fixed during 5 days every 12 hours. The chromatograms revealed that certain amino acids accumulated and some others decreased. These changes were — however — gradual and took place over a period of 15 days as shown by the analyses of leaves sampled daily after the 5th day. Fig. 1 shows chromatographic separations of free amino acids from the standard solution, from extracts of

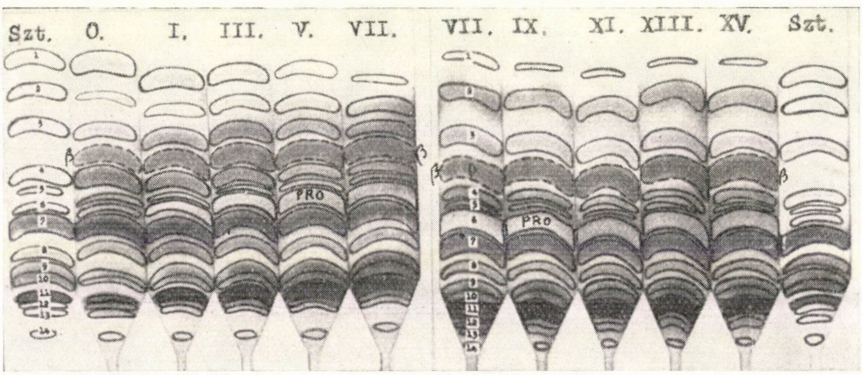


Fig. 1. Free amino acids of leaves of *Solanum laciniatum* Ait. The leaves were either fixed right after detachment or every second day after detachment. Illuminated. O—XV = date (days) of fixing after detachment. Szt = standard amino acid mixture, its composition:

1 = Leu	6 = Pro	11 = Asp—NH_2
2 = Phe	7 = Ala	12 = Arg
3 = Val + Met	8 = Glu + Thr	13 = Lys
4 = γ-Amb	9 = Ser + Gly	14 = Cys
5 = Tyr	10 = Glu—NH_2 + Asp	β = Pipecolic acid, blue spot

immediately fixed fresh leaves (control) and of wilting leaves which were fixed every other day.

It may be seen in Fig. 1 that the amino acids contained in the standard mixture had nearly the same R_f values as those of the extracts. There is one seldom occurring amino acid (pipecolic acid, not a protein constituent) with an R_f value of 0.64 (between γ-aminobutyric acid and valine) which is an exception to this. This amino acid gave a blue spot delineated with dotted lines in the Figure. First only the major quantitative changes observed on the chromatograms prepared from samples fixed every other day will be dealt with. Such a major change was displayed by leucine which had the highest R_f value. By the seventh day this amino acid decreased to one fifth of its amount in the freshly fixed control. On the following days it occurred only in traces. Phenylalanine (located just below leucine in the chromatogram) increased gradually and by the 15th day it amounted to 300 per cent of the control. The amount of valine plus methionine increased during 3 days to 200 per cent of the initial value and maintained this level until the leaves got dry. No considerable quantitative change was found with pipecolic acid during the 15 days of the experiment.

The greatest quantitative change was found with proline. As judged by the size and the colour intensity of the spot of proline from the freshly fixed sample its amount roughly corresponded to that of the standard, i.e. 5 μg. By the fifth day this quantity reached a twelve fold value which was maintained up to the end of the experiment.

The amino acid level of detached wilting leaves was compared to that of infected plants in the following host-parasite combinations: Rice — *Piricularia oryzae* Cav., soy bean — soy bean mosaic, potato — potato leaf roll virus (*Corium solani* Holmes), tobacco — tobacco mosaic virus (*Marmor tabaci* var. *vulgare* Holmes), *Sorghum* — Sorghum mosaic and *Solanum laciniatum* Ait. — *Phytophthora* sp. The amino acid pattern of diseased plants was in many ways similar to that of wilting leaves, especially with respect to their amide content, with the exception of the amount of proline, which did not increase to a considerable extent in diseased plants.

Another remarkable effect of wilting can be seen upon examining spots Nos 9 and 10 in Fig. 1. These spots represent glycine and serine and aspartic acid and glutamine, respectively. All of these four compounds have accumulated, the highest increase, however, is experienced with serine as judged by hydrolysis and two dimensional paper chromatography.

The amount of asparagine which appeared in spot No. 11 (Fig. 1) was about 5 μg in freshly fixed leaves. By the 5th day, similarly to proline, this amino acid reached its maximum concentration which was six times higher than that of the control. This high concentration of asparagine was maintained up to the end of the experiment.

The changes in the amino acid spectrum were followed by two dimensional thin layer chromatography as well. The layers were prepared such as to be thicker than usual, in order to be able to apply fairly large amounts of the extracts. In Fig. 2 and Fig. 3 the thin layer chromatograms of freshly fixed samples and of samples which were fixed on the 3rd day are represented. Here, too, a decrease of leucine and an increase in phenylalanine, valine, proline, serine, glutamine and aspartic acid are to be observed. It has to be noted that amino acids occurring in very small amounts are difficult to detect on two dimensional chromatograms, especially on two dimensional thin layer chromatograms. Even if some amino acids do not show up at all, dramatic changes

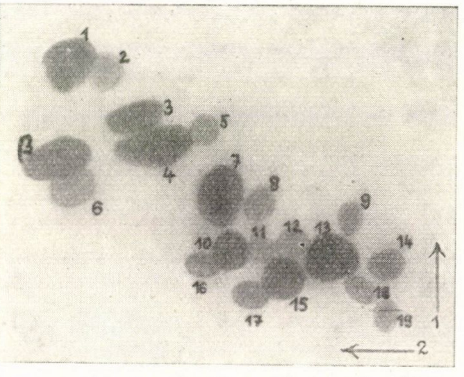


Fig. 2. Thin layer chromatogram showing the free amino acids of leaves of *Solanum laciniatum* Ait. fixed right after detachment.

1 = Leu	6 = Pro	11 = Gly	16 = Arg
2 = Phe	7 = Ala	12 = Glu	17 = Lys
3 = Val + Met	8 = Thr	13 = Ser	18 = Orn
4 = γ-Amb	9 = O-Glu	14 = Asp	19 = Cys
5 = Tyr	10 = Glu-NH_2	15 = Asp-NH_2	20 = Putr

β = pipecolic acid

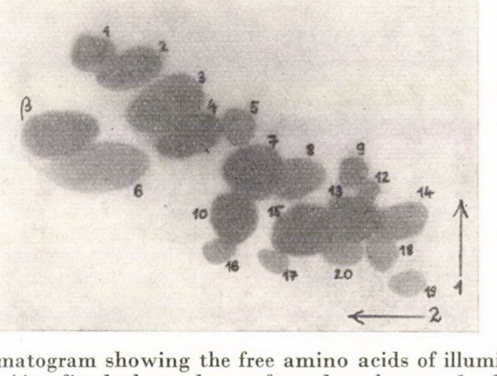


Fig. 3. Thin layer chromatogram showing the free amino acids of illuminated leaves of *Solanum laciniatum* Ait., fixed three days after detachment. 1—20 = see Fig. 2. β = pipecolic acid

in the content of some amino acids which occur in large amounts are nevertheless detectable.

The analyses of samples taken daily for 15 consecutive days from plants which were wilting in the dark revealed considerable differences if compared to the analyses of plants which were given a 10-hour illumination every day. The quantitative changes can briefly be summarized by saying that for five days there is a rapid increase in the total amino acid content followed by a decrease.

A chromatogram of an extract of plants illuminated every day is compared in Fig. 4 to a chromatogram of an extract of plants kept in the dark.

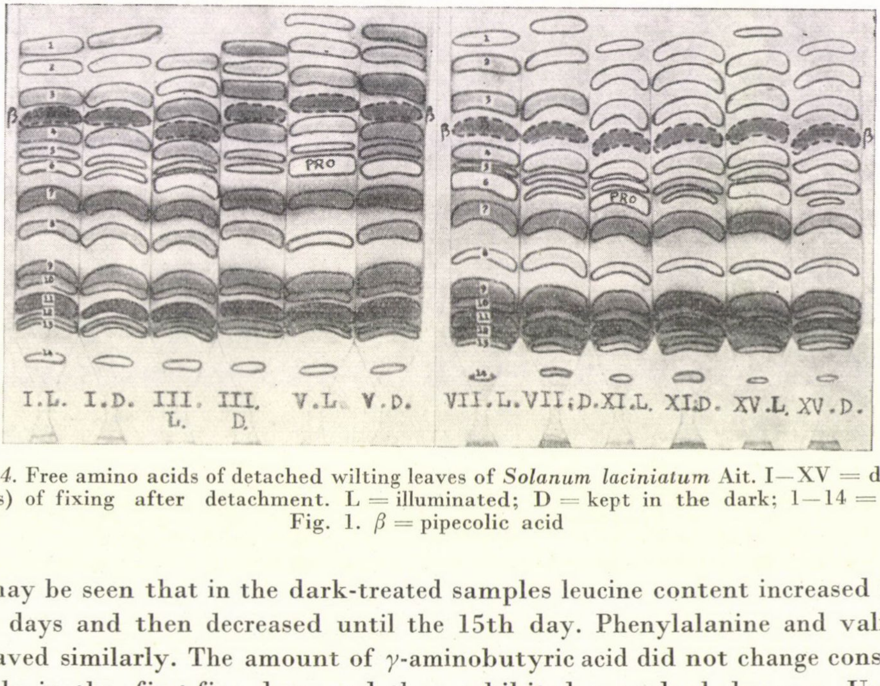


Fig. 4. Free amino acids of detached wilting leaves of *Solanum laciniatum* Ait. I—XV = date (days) of fixing after detachment. L = illuminated; D = kept in the dark; 1—14 = see Fig. 1. β = pipecolic acid

It may be seen that in the dark-treated samples leucine content increased for five days and then decreased until the 15th day. Phenylalanine and valine behaved similarly. The amount of γ-aminobutyric acid did not change considerably in the first five days and then exhibited a gradual decrease. Upon comparing the light-treated and dark-treated samples the largest difference was found with proline: in the light-treated leaves it reached by the fifth day an extremely high concentration which was maintained up to the end of the experiment whereas in the leaves which were wilting in the dark it also accumulated to reach a concentration five times higher than that of the control, later on however, it suddenly decreased and by the 15th day there was less proline in these leaves than in the control. In the leaves kept in the dark the amounts of alanine, glutamic acid, serine, glutamine and asparagine increased for five days and then decreased. The asparagine content of the leaves which were wilting in the dark increased for 5 days and was maintained at the same level up to the time of total desiccation, similarly to the illuminated variant. Of the significant changes this is the only one which follows the same trend in both illuminated and dark-treated leaves.

To see whether the changes in the free amino acid spectrum of wilting leaves is in any way correlated with changes in the spectrum of protein bound amino acids, protein hydrolysates were also analyzed as to their amino acid

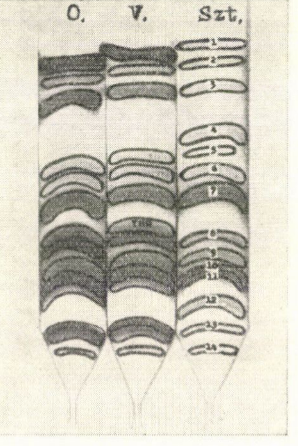


Fig. 5. Amino acid composition of hydrolyzed leaf protein of *Solanum laciniatum* Ait. V = from a leaf which was wilting for five days. 1—14 = see Fig. 1

composition. In view of the fact that the greatest difference was found on the 5th day it is the amino acid spectrum of protein hydrolysates of samples fixed on the very 5th day which is shown in Fig. 5.

It can be seen that freshly fixed leaves contained more protein on a dry weight basis than leaves which were wilting for 5 days. No difference was found, however, between the two types of sample with respect to the amino acid composition of their protein. This also holds for proline, i.e. although among the free amino acids proline showed the highest increase upon wilting, its concentration did not decrease in the protein of wilting leaves. Thus the increased proline content of wilting leaves is not due to protein breakdown but rather is a consequence of the conversion of free amino acids or some other compounds into proline.

Discussion

The amino acid spectra of leaves which are wilting in the light and in the dark, respectively, are similar in that their total amino acid content and especially their amide content are on the increase. There are many similarities between the free amino acid pattern of wilting leaves and that of diseased plants. There is, however, a very conspicuous difference, namely, in detached wilting leaves proline accumulates to a very high extent. In our experiment a twelve-fold increase in proline was found to take place by the 5th day of wilting as compared to the amount of this amino acid in leaves that were detached and fixed immediately. In diseased plants (rice, potato, tobacco, soy bean, sorghum and *Solanum laciniatum* Ait.) no such change was found. The increase in the total amino acid content of detached leaves during wilting reached its maximum value within 5 days. The amino acid composition of detached leaves illuminated for 10 hours a day differed from that of detached leaves kept in the dark. Whereas with the illuminated leaves the high proline concentration remained at the same level up to the end of the experiment (15th day), with the dark-treated leaves the proline level exhibited a sudden decrease after the fifth day and by the 15th day went below that of the freshly fixed leaves.

KYDREV—TYANKOVA (1966) also found a high proline concentration in wheat plants exposed to drought for a short period. In their experiments when such plants were given an optimal water supply the normal amino acid spectrum was finally restored even if this occurred only after several days. It may be supposed that proline is to neutralize ammonia, which accumulates as a consequence of protein breakdown during the wilting process.

COIC *et al.* (1963) have found that a rich nitrogen supply leads to the accumulation of proline in both wheat and barley. These authors have suggested that proline plays a role in storing nitrogen. BRITIKOV *et al*, (1965) have shown that proline that does not getinc orporated into proteins is metabolized during respiration.

SAVITSKAYA (1965) has investigated the free amino acid content of barley in the case of soil water deficiency. According to her data it was mainly proline that accumulated. In addition, the level of valine also increased, whereas that of alanine and glutamic acid decreased. These results are in line with our observations on the changes in the amino acid spectrum of wilting leaves, although they have been obtained with undamaged plants exposed to drought. The observed similar changes in the amino acid spectrum of both detached wilting leaves and plants exposed to drought suggest that also in plants suffering from water deficiency the regulatory role of roots in the metabolism of the shoots is annihilated.

According to the data of SINGH *et al.* (1960) in rice shoots the largest quantity of proline was found in old dying leaves. This also points to degradation.

In our experiments the high proline concentration does not seem to originate from a preferential degradation of leaf proteins since the amino acid composition of protein hydrolyzates was the same with respect to the proline content as well.

Our results have revealed that there was a considerable difference in the proline content between the daily illuminated leaves and the leaves kept in the dark all the time, especially on the fifth day after they had started to wilt. This suggests that during wilting chlorophyll metabolism also undergoes some changes and that in this process light plays an important part. This is supported by the finding that kinetin treatment of detached yellowing tobacco half leaves leads to their becoming green (Farkas *et al.* 1963/64, Kulaeva 1964). Duranton—Maille (1961) by using ^{14}C labelled proline have shown that there is a connection between proline metabolism and chlorophyll biosynthesis. Breyhan *et al.* (1961) have also pointed out that proline takes part in chlorophyll biosynthesis, as in their experiments the proline in potato tubers germinated in the dark was converted to porphobilinogene.

At any rate, it can be concluded that the amino acid spectrum of detached wilting leaves is most similar to that of the leaves of intact plants exposed to drought. This suggests that in detached leaves the primary damaging factor is water deficiency which sets in at once. In this case, presumably, chlorophyll is degraded at first.

REFERENCES

Breyhan, Th.—Heilinger, F.—Fischnich, O. (1961): Stoffwechsel- und entwicklungphysiologische Untersuchungen an Kartoffelkeimen. II. Quantitative Analyse der Aminosäuren von im Dunkelheit gebildeten Kartoffelkeimen. Landbauforsch. Völkenrode, 11, 65—68.

Britikov, E. A.—Vladimirceva, S. V.—Musatova, N. A. — Бритиков, Е. А. — Владимирцева, С. В. — Мушатова, Н. А. (1965): О превращении пролина в прорастающей пыльце и тканях пестиков. Физиол. раст. **12,** 953—967.

Coic, Y.—Fauconeau, G.—Pion, R.—Busson, F.—Lesaint, Ch.—Labonne, F. (1963): Influence de l'alimentation minerale sur la composition des protides des graines de céréales. Ann. physiol. végét., **5,** 281—292.

Duranton, H.—Maille Monique (1961): Étude du métabolisme de la proline en relation avec la synthese des pigments chez le topinambour. C. r. Acad. Sci., **253,** 1003—1005.

Farkas, G. L.—Dézsi, L.—Horváth, M.—Kisbán, K.—Udvardy, J. (1964): Common Pattern of Enzymatic Changes in Detached Leaves and Tissues Attacked by Parasites. Phytopath. Zeitschrift, **49,** 343—353.

Kulaeva, O. N. — Кулаева, О. Н. (1964): К вопросу о влиянии корневой системы на обмен веществ. Изд-во Наука. Москва.

Kydrev, T. G.—Tyankova, L. A. — Кидрев, Т. Г. — Тянкова, Л. А. (1966): Влияние ИУК и 2,4—Д на содержание свободных и связанных аминокислот пшеницы после воздействия кратковременной засухи. Физиол. раст. **13,** 988—995.

Pálfi, G. (1964): Eine neue, ninhydrin- und isatinpositive, aminosäureähnliche Verbindung aus Reisblättern, die das Maß der Stickstoffversorgung anzeigt. Naturwissenschaften, **51,** 489.

Pálfi, G. (1965a): Relations between Abundant N-supply and the Amino Acid Concentration of Various Leaf Levels of Rice Plants. Plant and Soil, **23,** 275—284.

Pálfi, G. (1965b): The Effect of Sodium Salts on the Nitrogen, Phosphorus, Potassium, Sodium and Amino Acid Content of Rice Shoots. Plant and Soil, **22,** 127—135.

Pálfi, G.—Barkóczi, M.—Dézsi, L. (1966): "Blue Test" as an Indication of the Irregular Amino Acid-protein Metabolism in Rice. Il Riso, **15,** 285—292.

Singh, M.—Kumazawa, K.—Mitsui, S. (1960): Asparagine Test in Relation with the Nitrogen Nutritional Status of Crop Plants. V. Rice. Soil and Plant Food, **6,** 86—90.

Szalai, I. (1957): Photometrische Bestimmung des Gesamtaminosäurespiegels im Kartoffelsaft mittels der Ninhydrinreaktion. Acta Biol. Szeged. Hung., **3,** 33—40.

Savitskaya, N. N. — Савицкая, Н. Н. (1965): О содержании свободных аминокислот в растениях ячменя при недостатке воды в почве. Физиол. Раст. **12,** 349—350.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 389—396 (1968)

THE EFFECT OF ADDED L-LYSINE IN DEFICIENT DIETS FOR GROWING CHICKS ON GROWTH AND EFFICIENCY OF FEED UTILIZATION

By

A. M. DARWISH

DEPARTMENT OF ANIMAL PRODUCTION, FACULTY OF AGRICULTURE, ASSUIT UNIVERSITY, ASSUIT

The concepts of suitable and economic values of lysine supplementation in feeding Hungarian White Leghorn from 21—81 days of age have been extensively studied.

The data presented in this investigation demonstrated that 1.20 per cent lysine in the diet improved the growth and feed conversion in both sexes of chicks during the period from 21 till 66 days of age. For a longer period than 66 days of age seemed to be undesirable to use 1.20 per cent level since it decreased the daily gain and raised the growth measure, the most suitable level during that period (66—81 days of age) was 0.90 per cent lysine in the diet. Such results indicated that the lysine requirement was higher in the early growing period of the chick than that of the older one of the same breed due to the higher speed of growth.

There was no growth inhibition caused by moderately excessive lysine levels during the early growing period (21—66 days of age).

Introduction

The correct quantity of lysine in the diet of the chick for optimum growth and efficiency of feed utilization has been tested by several workers, e.g. JEPPESEN—GRAU (1948), MARCH *et al.* (1950), RICHARDSON—BLYLOCK (1950), MILLIGAT *et al.* (1951), ALMQUIST (1952), EDWARDS *et al.* (1956), DEAN—SCOTT (1965).

It has been indicated that there is some agreement among several workers on the requirement of lysine, but a wider range appears to be necessary in examining this problem.

Beside the requirement of lysine other factors seem to be involved as the age of the bird, i.e. the requirement of lysine related to speed of growth in the young fowl. The amino acid is concentrated to the highest degree in the muscle and other tissues. The requirement therefore, may be relatively higher in faster growing fowl.

Another respect of this problem is the genetic background of the bird as a factor influencing the requirement of lysine. EDWARDS *et al.* (1956), NESHEIM—HUTT (1962), GORDON (1963), ENOS—MORENG (1964) and NESHEIM *et al.* (1964) have presented certain aspect of racial dependence in amino acid optimums. Therefore, it should be borne in mind that — under given climatic conditions — the proper requirement of lysine of Hungarian White Leghorn chickens is worthy of intensive studies.

Materials and Methods

For the present investigation 140 White Leghorn chickens commonly bred in Hungary (42 males and 98 females), 21 days old, were procured from the Farm of Faculty of Agriculture, Keszthely, Hungary. In May 1966 the experiment started and continued for sixty days. The duration of the experiment was divided into four periods lasting 15 days each.

The birds were housed in electrically heated battery brooders with wire mesh floors. Each chick was weighed and marked with a numbered wing band and weighed per two/week thereafter early in the morning prior to feeding before each period and at the end of experiment.

Feed and water were given ad-libitum and a daily record of feed consumption was kept. The composition of the basal ration used in the experiment is given in Table 1.

The ration was supplemented by minerals, salt and vitamins. The total digestible nutrient (T. D. N.) of this ration was 62.36 per cent as fed, the total crude protein was 16.76 per cent as fed. These values of the protein and T. D. N. of the ingredients were practically obtained in a previous work by the author (in press *a*) except in case of the fish meal; the data were calculated according to TITUS (1961).

The rations offered to the different groups were adjusted at a level of 0.90 per cent sulphur amino acids. This level has been recently obtained by the author (in press *b*).

Table 1

Composition of basal ration fed in various groups

Ingredient	%	Protein gm	Lysine gm	Total digestible nutrient gm
Ground maize	50.0	4.97	0.150	36.60
Ground wheat	20.0	2.02	0.060	14.30
Pea nut meal	15.0	6.09	0.190	5.52
Wheat bran	6.0	0.85	0.020	2.62
Lucerne meal	1.4	0.23	0.012	0.56
Fish meal	4.0	2.60	0.205	2.76
Total	96.4	16.76	0.637	62.36

The analytical method i.e. the paper chromatography for amino acid determination elaborated by RICHARD *et al.* (1960) has been applied.

The chickens were divided into three groups. Group I (12 males and 28 females) reared on basal ration deficient in lysine (0.637 per cent). Chicks in Group II (12 males and 28 females) and Group III (18 males and 42 females) received basal ration with added L-lysine at a rate of 0.263 per cent and 0.563 per cent, respectively. The total lysine in the ration of Group II and Group III was 0.90 and 1.20 per cent, respectively.

The average weight has been calculated. The daily gain, growth measure (daily T. D. N. consumed per daily gain in grams) and the relative growth rate (the final body weight in grams per the age of the bird in days) were estimated after BRODY (1959) and DARWISH *et al.* (in press).

In order to evaluate the differences obtained among the groups at separate and combined intervals a Student's "t" test, analysis of variance and the least significant difference (L. S. D.) were carried out according to SNEDECOR (1956).

Results

The avarage daily requirements (T. D. N.) per individual in Group I was 40.40 gm (T. D. N.) during the first period and increased in the following periods, reaching 84.18 gm T. D. N. during the last period. In Group II the average daily requirement was nearly the same as that of Group I during the first and last periods but it was slightly higher during the second and third periods.

In contrast, in Group III daily requirement was found slightly higher in the first and last periods but lower in the second and third periods as compared to the corresponding data of Group I.

The average daily gain of male chicks is shown in Table 2. It was higher in Group III than that of Group I during the first, second and third periods, but conversely in the last period. The higher differences occurred in the second and third periods.

Comparing the average daily gain values of Group I and Group II, higher one was found during the four periods in Group II than in Group I. The higher variation occurred in the last period (34.00 ± 2.70 and 40.98 ± 2.06). The increase proved to be statistically significant ($P < 0.05$).

It is evident from Table 2 that the average growth measure was lower in Group III than that of Group I during the four periods. Although the average growth measure of chicks in Group III was lower than that of Group II during the second and third periods, it was higher in the other two periods.

The results in Table 3 show that average daily gain of female chicks in Group III was higher than that of Group I during the four periods. It was also higher (except the last period) than that of Group II. The higher variation between Groups II and III occurred in the third period. The difference was statistically significant ($P < 0.05$), but in the fourth period the daily gains of the chicks in Group II were slightly higher than in Group III.

On the other hand the average growth measure of chicks in Group III was lower than that of Groups I during the four periods. Comparing the data of the growth measure between Group II and Group III, lower growth was found in Group II during the first and last periods but higher one in the second and third periods.

The results of the whole experiment (from 21 days to 81 days of age) summarized in Table 4, indicated that the average daily T. D. N. consumed by Group III was less than that of Group II, but slightly higher than Group I.

The average daily gain of chicks in Group III was higher than in the other two groups of both sexes.

The growth measure of the two sexes of Group III was lower than that of the other two groups.

Table 2

Average daily requirements, daily gain and growth measure

Group	I.			
Period	1	2	3	4
T.D.N. gm	40.40	56.42	72.42	84.18
Daily gain	20.55	31.33	34.00	34.00
gm	±1.24	±1.53	±3.67	±2.70
Growth measure	1.97	1.80	2.13	2.48

Table 3

Average daily requirements, daily gain and growth measure

Group	I.			
Period	1	2	3	4
T.D.N. gm	40.40	56.42	72.42	84.18
Daily gain	19.13	27.38	28.57	29.25
gm	±0.863	±1.37	±1.72	±1.81
Growth measure	2.11	2.06	2.53	2.88

Although the relative growth rate of male and female chicks of Group II was lower than that of Group III, it was higher than that of Group I.

Statistical data of daily gain in males shown at Table 5 prove obviously the high significance of variances due to the duration of experiment ($P < 0.05$).

Altough there was no statistical difference among the groups, there was a significant difference in the daily gain between Group I and Group III (calculated $F_{0.05} = 5.98$, theoretical $F_{0.05} = 5.39$). Applying the least significant difference (L. S. D.) between Group I and Group III, the difference was significant. The results of female chicks given in Table 6 showed that variance due to the periods of the experiment is highly significant ($P < 0.05$) although there was no significant increase in the value of the daily gain between Group I and Group III (calculated $F_{0.05} = 6.95$, theoretical $F_{0.05} = 5.39$).

Appyling the L. S. D., the difference between Group I and Group III was significant.

Discussion

From the present study it appears that the addition of L-lysine to the deficient diet improved the feed conversion and growth of chickens during the first, second and third periods. Furthermore the results showed that during *among different groups of male chickens in the four periods*

II.				III.			
1	2	3	4	1	2	3	4
40.08	59.64	78.62	84.37	41.97	55.81	71.27	86.02
21.50	31.43	34.19	40.98	22.25	35.65	38.70	36.35
±1.18	±1.53	±1.82	±2.06	±0.65	±1.58	±1.43	±2.09
1.86	1.89	2.29	2.06	1.88	1.57	1.84	2.37

among different groups of female chickens in the four periods

II.				III.			
1	2	3	4	1	2	3	4
40.08	59.64	78.62	84.37	41.97	55.81	71.27	86.02
19.59	29.17	27.70	30.26	20.10	29.23	32.67	29.55
±2.73	±1.60	±1.87	±1.77	±2.18	±1.15	±1.23	±1.63
2.04	2.04	2.83	2.79	2.09	1.91	2.18	2.91

these three periods (21—66 days of age) three diets containing 0.637, 0.90 and 1.20 per cent lysine given to Group I, Group II and Group III, respectively, the improvement in the feed utilization and weight gain was progressive. In other words, the higher the level of lysine in the ration, the bigger the improvement in growth and efficiency of feed utilization. This indicates that supplemented lysine at a rate of 1.20 per cent in the diet for both sexes of Hungarian White Leghorn growing chicks resulted maximum growth and maximum feed conversion under Hungarian environmental condition during the period 21—66 days of age. This finding is in agreement with the recommended value of Dean—Scott (1965). The value obtained by Richardson—Blylock (1950) and Edwards *et al.* (1956) for the fast growing chicks, was slightly lower being 1.10 per cent lysine in the diet. The lysine requirement for growing chicks being 1.0 per cent of the diet containing 20.0 per cent protein has been recorded by Milligen *et al.* (1951) and the National Research Council (1960).

During the last period (66—81 days of age) the higher level (1.20 per cent) seemed to be undesirable since it decreased the daily gain of male chicks in Group III in comparison to that of Group II. This daily gain of Group II was during the last period also higher than that of Group I. The increase was statistically significant ($P < 0.05$). The growth measure of male chicks in Group II was less than those of Group I and Group III. The reduction in the

Table 4

v erage daily requirements, daily gain, growth measure and relative growth rate among different groups and sexes of chickens during the experimental periods (21—81 days)

Group	I		II		III	
	Male	Female	Male	Female	Male	Female
Daily total digestible nutrients (T.S.D.) gm ..	63.36		65.68		63.77	
Daily gain gm	29.97	26.08	32.03	26.68	33.19	27.89
Growth measure	2.11	2.42	2.05	2.46	1.92	2.27
Relative growth rate gm	27.6	23.3	28.6	23.8	29.0	24.8

Table 5

Analysis of variance in daily gain of the male chickens in the three groups studied in different periods of growth

Source of variance	Degrees of freedom (D.F.)	Sum square (S.S.)	Mean square (variance)	F calculated	F tabulated 5%
Periods	3	453.98	151.33	31.51	4.76
Groups	2	24.37	12.19	2.55	5.14
Residual	6	28.61	4.77		
Total	11	506.96			

L.S.D. = 2.70

Table 6

Analysis of variance in daily gain of female chickens in the three groups studied in different periods of growth

Source of variance	Degrees of freedom (D.F.)	Sum square (S.S.)	Mean square (variance)	F calculated	F tabulated 5%
Periods	3	214.17	71.39	57.11	4.76
Groups	2	6.80	3.4	2.72	5.14
Residual	6	7.49	1.25		
Total	11	228.46			

L.S.D. = 1.59

growth measure of Group III is 20 per cent and 15 per cent less than that of Group I and Group III, respectively.

In case of the females the average daily gain of Group II was higher than that of Group I and Group III.

On the other hand, the feed conversion for Group II has also improved, the growth measure was lower than those of the other two groups. These results indicate that the most suitable lysine level during this period (66—81 days of age) for maximum growth and feed conversion was 0.90 per cent in the diet. This value has been recorded by JEPPESEN—GRAU (1948) and MARCH *et al.* (1950).

Such results indicate that the lysine requirement is more in young fowls (1.20 per cent) than in the later phases of development within the same breed, due to the fact that the lysine is concentrated in the highest degree in the muscles and in other tissues. Therefore, the requirement may be relatively higher in the early growing period due to the higher speed of growth. This finding was in agreement with that obtained by GARTLEY *et al.* (1950).

In this aspect MITCHELL (1950) has observed similar differences in amino acid requirements of rats and human beings and connected the requirement with species differences in the intensity of demand at different ages for formation of keratin protein, as compared to protoplasmic proteins.

From the results of the present investigation good evidence can be obtained concerning the positive effect of higher lysine supplementation on growth and feed conversion, when diet is deficient. In other words the higher added lysine to the deficient diet, the more intense improvement happens in growth and feed utilization.

On the other hand, there was a progressive improvement in the feed utilization by supplementation of the diet by lysine. The average growth measure of Group III was lower than that of Group I, and Group II in both sexes. The results obtained by GRAU (1948), GRAU—KAMEI (1950) and KRATZER *et al.* (1950) did not show an inhibitory effect of lysine at excess levels, being in agreement with the results obtained in this investigation. In contrast MARCH *et al.* (1950) have observed a growth depression by excess lysine.

Acknowledgement

The author is thankful to Dr. J. Potsubay, Head of Department of Anatomy and Animal Physiology, Agricultural Faculty Keszthely, Hungary, for providing research facilities and encouragement in the course of investigation.

REFERENCES

ALMQUIST, H. J. (1952): Amino Acid Requirements of Chicks and Turkeys — a Review. Poultry Sci., **31**, 966—981.

BRODY S. (1959): "Bioenergetics and Growth". N. Y. Reinhold.

DARWISH, A. (in press a): The Determination of the Digestibility of some Feedstuff in Chicks Using a Chemical Method. Faculty of Agric. Assuit Univ., Egypt.

DARWISH, A. (in press b): The Effect of Added DL-methionine in Deficient Diets for Growing Chicks on Growth and Efficiency of Feed Utilization. Faculty of Agric. Assuit Univ., Egypt.

DARWISH, A.—AMROUSI, S. EL.—SOLIMAN, M. K. (in press): Growth and Feed Utilization of Fayoumi Pullets as Affected by Tranquillizers. Faculty of Agric. Assuit. Univ., Egypt.

DEAN, W. F.—SCOTT, H. M. (1962): The Development of an Amino Acid Standard for the Early Growth of Chick. Poultry Sci., **41**, 1940.

Edwards, H. M.—Ir.-Norris, L. C.—Heuser, G. F. (1956): Studies on the Lysine Require ment of Chicks. Poultry Sci., **35**, 385—390.

Enos, H. L.—Moreng, R. E. (1964): Evidence of Genetic Variability for Lysine Utilization. Poultry Sci., **43**, 1315.

Gartley, K. M.—Slinger, S. J.—Hill, D. C. (1950): Further Observation on the Use of Sunflower Seed Oil Meal in Turkey Starter Rations. Poultry Sci., **29**, 312—313.

Gordon, R. S. (1963): Growth Arrest through Tryptophan Deficiency in the very Young Chicken. Proc. 6th Int. Congress of Nutr., Edinburgh.

Grau, C. R. (1948): Effect of Protein Level on the Lysine Requirement of the Chick. I. Nutrition, **36**, 99—108.

Grau, C. R.—Kamei, M. (1950): Amino Acid Inbalance and the Growth Requirement for Lysine and Methionine. I. Nutrition, **41**, 89—101.

Jeppesen, J. H.—Grau, C. R. (1948): WholeWheat Protein as an Amino Acid Source for Chicks. Poultry Sci., **27**, 588—590.

Kratzer, F. H.—Villiams, D. E.—Marshall, B. (1950): The Relation of Lysine and Protein Level in the Ration to the Development of Feather Pigment in Turkey Poults. Poultry Sci., **29**, 285—292.

March, B.—Biely, J.—Tonzetich, J. (1950): Supplementation of Wheat with Amino Acids in the Diet of the Chick. I. Nutrition, **42**, 565—576.

Milligat, J. L.—Machlin, L. J.—Bird, H. H.—Heywang, B. W. (1951): Lysine and Methionine Requirement of Chick Fed Practical Diets. Poultry Sci., **30**, 578—586.

Mitchell, H. H. (1950): Some Species and Age Differences in Amino Acid Requirements of Mammals. A. A. Albanase, Editor. Academic Press Inc. New York.

National Research Council (1960): Nutrient Requirements of Domestic Animals. No. 1. Nutrient Requirements for Poultry.

Nesheim, M. C.—Hutt, F. B. (1962): Genetic Differences among White Leghorn Chickens in Requirements for Arginine. Science, **137**, 691—692.

Nesheim, M. C.—Christiensen, D. A.—Arnold, D. L.—Hutt, F. B. (1964): Nutritional Studies with Lines of White Leghorn Chickens Selected for Differences in Arginine Requirements, Poultry Sci., **43**, 1346—1347.

Richard, J. B.—Emmett, L. D.—Zweig, G. (1960): "A manual of paper chromatography and paper electrophoresis". New York Academic Press. Inc. publishers.

Richardson, L. R.—Blylock, L. G. (1950): Vitamins B_{12} and Amino Acid as Supplements to Soybean Oil Meal and Cottonseed Meal for Growing Chicks. I. Nutrition, **40**, **169**—176.

Snedecor, G. W. (1956): "Statistical Methods" 5th Ed. The Iowa State College Press. Ames. Iowa.

Titus, H. W. (1961): "The Scientific Feeding of Chickens" 4th Edit. Lib. of Congress Catalog. card. number, **61**, 5799. I.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 397—404 (1968)

INVESTIGATIONS ON THE DRY MATTER CONTENT OF TOMATO

By

L. VIDÉKI

AGRICULTURAL EXPERIMENT STATION, KECSKEMÉT

In order to throw some light on the causes of the qualitative deterioration of tomato during the past few years an attempt was made for seven consecutive years to correlate the dry matter content of tomato with the meteorological factors (temperature, precipitation).

Dry matter content of tomato was shown to vary from year to year to a considerable extent. The highest value (8.1 per cent) was found in 1962 and the lowest (5.0 per cent and 4.9 per cent) in 1965 and 1966, respectively.

The temperature and precipitation prevailing at the time of harvest (June, July, August) cannot explain the big variations, because no correlation has been found between temperature and dry matter content and the correlation between precipitation and dry matter content was also insignificant. A closer correlation was found, however, between the climate in spring and dry matter content. Yield and dry matter content of fruits seem to be inversely correlated.

Introduction

Most papers dealing with the qualitative amelioration of tomato lay a special emphasis on the increase in dry matter content (DASKALOFF *et al.* 1965, FLOCKER *et al.* 1961, JOHN *et al.* 1956, MASSEY—WINSOR 1956, MÉSZÖLY 1949, ROTONDA 1956, RUBIN—METLITSKIJ 1949, SAMOGGIA 1961, SILVESTRI—PORCU 1963, STOJKOV 1954, VIDÉKI—BONTOVITS 1957, VLADIMIROV 1964, WINSOR—MASSEY 1957). In Hungary too, the authorities are concerned with the elaboration of a method of evaluating the quality of tomato from the point of view of acceptance. The first attempts to accept tomato on the basis of such principles have already been made in Bulgaria (VIDÉKI—BÁLDY 1964, VLADIMIROV 1964). This problem came into prominence during the last few years, when, contrary to the experience of former years, there was a considerable decrease of dry matter content accompanied by high yields. The question arises whether this qualitative deterioration of tomato is merely due to climatic factors or else, the varieties also play a part.

Materials and Methods

The experiments have been conducted on plant material originating from the quality seed growing plots of the Agricultural Experiment Station, Kecskemét. These plots were set up in each year on the same type of soil and subjected to the same cultivation practices.

After the harvest of winter cereals the semihard soil was stubbled and fertilized with 200 q turf, 200 kg potassium salt, 200 kg superphosphate and 150 kg Péti-salt by autumn deep ploughing. Spring cultivation consisted of harrowing, fertilization, harrowing, ridge ploughing twice and levelling. The rates of fertilizers were as follows: 100 kg superphosphate, 50 kg 60 per cent potassium chloride and 50 kg 34 per cent Péti-salt. About May 5 to May 10 6-week-old seedlings were planted. The distances were: 90 + 40 × 35 cm for determined varieties, 120+40 × 40 cm for semi-determined varieties and 140 + 40 × 40 cm for the ordinary types. During the vegetation period hoeing was carried out three times, and ridge-ploughing four times.

The following varieties were used for the analyses: *K 363*, *K 42*, *K Merevszárú*, *K Törpe* and *K. D. San Marsano* (K. D. SM). The reason for choosing these varieties was, that for the past 6 years they have always been included into the trials for producing quality seed. The analyses were carried out three times a year, at different stages of ripening, with samples weighing 1 kg each. The plant tissues were homogenized in a Waring Blendor. Dry matter content was determined by the use of an Abbé refractometer (Zeiss). Since the measurements were done at a temperature near 20° C, neither a thermostat nor corrections for temperature were used. At the same time, however, the results were compared with those obtained by using a drying chamber. In accordance with the opinion of some other authors (JÁMBOR—MÉSZÁROS 1951, KUTHY 1949, RUBIN—METLICKIJ 1949, STOJKOV 1954, VIDÉKI—SZEMES 1966) we did not find either any difference between the results obtained by the two above methods.

Results

During the past two years the dry matter content of tomato was extremely low whereas the average yields were very high. This was a problem mainly for the industry because it could hardly fulfill his obligations which had been guaranteed by the contracts on the one hand, and could not work up all raw material received to manifacture finished products, on the other. Several other authors have been concerned with this very problem and more and more emphasis has been laid on the importance of dry matter content (BONTOVITS 1964, MÉSZÖLY 1966).

The Factory of Canned Products of Kecskemét has published data on the dramatic decrease of the dry matter content of tomato during the past few years. Whereas in the years 1962, 1963 and 1964 it was 6.2 per cent, 5.3 per cent and 5.0 per cent, respectively, in 1965 it dropped to 4.4 per cent and in 1966 to 4.1 per cent (KOVÁCS 1966). The dry matter contents of the varieties analyzed in our Institute are shown in Table 1. As it can be seen the dry matter content was found to be extremely low in our own experiments, too, and even in 1961 it did not reach a value of 6 per cent. At the same time in 1962 the dry matter content was very high and in 1964 it still was higher than the average.

Next, 5 varieties were again chosen and the average of their dry matter content was calculated in such a way as their belonging to a certain experiment was disregarded. In this way the average values were independent both of the area and of the experiment. The results obtained were similar to those obtained with the varieties shown in Table 1 (Fig. 1). Here, too, the dry matter content of the varieties in the years 1960, 1962 and 1964 was higher than the average. These data supported the reliability of those obtained with the varieties originating from the plot used to produce quality seed.

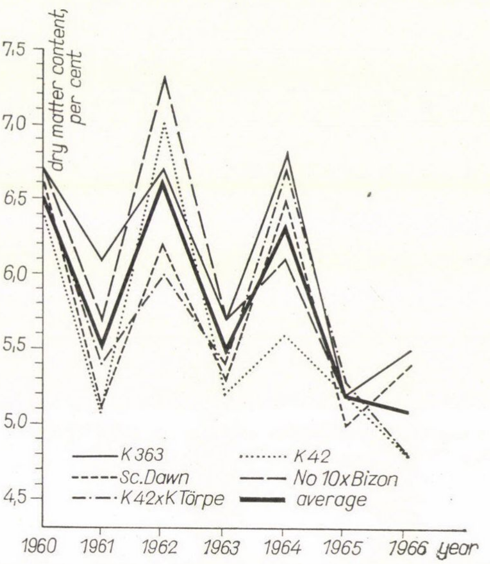


Fig. 1. Dry matter content of tomato in 1960—1966

Table 1

Changes in the dry matter content of tomato in the years 1960 to 1966

Variety	Dry matter content, per cent						
	1960	1961	1962	1963	1964	1965	1966
K 42	6.0	5.7	8.9	6.7	6.7	4.5	4.8
K 363	7.3	6.7	8.3	6.6	7.5	6.2	5.5
K Törpe	6.0	5.2	6.8	5.2	6.2	4.8	4.6
K Merevszárú	6.4	5.4	7.4	5.3	6.3	4.4	4.7
K. D. SM.	6.2	6.0	9.1	6.3	7.2	5.3	4.9
Average	6.4	5.8	8.1	6.0	6.8	5.0	4.9

The varieties investigated showed the same trend as far as their dry matter contents in the experimental years were concerned (Fig. 1). It was shown that the dry matter content of all five varieties was lower in 1961 than the average value for the previous year and in 1962 all five varieties had a higher dry matter content than the average value for 1961. In 1963 there was again a sudden drop.

Our data show that the cause of such drastic changes in dry matter content must be sought for in some very efficient factor. It is most probable that among the meteorological factors it is the temperature and the distribution of precipitation, prevailing at the time of ripening which mostly influence the dry matter content of tomato.

There are several literary data relating the chemical composition of tomato to climatic conditions (BONTOVITS 1952, SAMOGGIA 1961, SOMOS 1959, SZILÁGYI 1963, YAMAGUCHI—HOWARD 1960). The most fundamental of these is SZILÁGYI's paper analysing the effect of some meteorological factors prevailing during the early ripening period of tomato fruits on the quality of tomato.

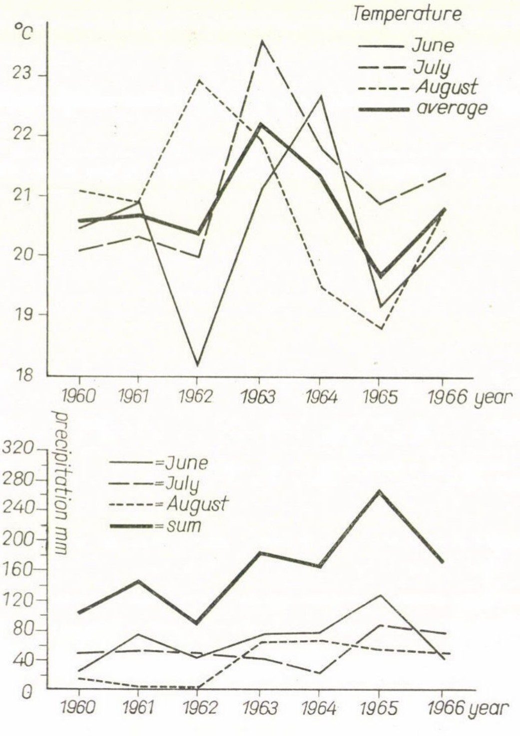


Fig. 2. Temperature and precipitation during the ripening period (June, July, August)

Higher temperatures had a favourable effect on the dry matter content of tomato whereas no correlation was found between precipitation and dry matter content.

Since dry matter content varied considerably from year to year and there were indeed dry and hot as well as humid and cold summers, an attempt was made to find a correlation between the temperature and the amount of precipitation characteristic of the summer months (June, July, August), on the one hand, and the dry matter content, on the other. The values for the temperature and precipitation are shown in Fig. 2. By comparing Fig. 1 with Fig. 2 hardly any correlation can be found. Dry matter content was surprisingly high in 1962 and 1964, whereas the temperature was just the opposite during all three months of the above years.

In order to find the real cause of the decrease in dry matter content the climate of earlier months has also been taken into consideration, although it was hard to suppose that the climatic conditions of April would influence the chemical composition or the dry weight content of the fruits. It is easier to imagine that the climatic conditions of earlier months would rather affect the

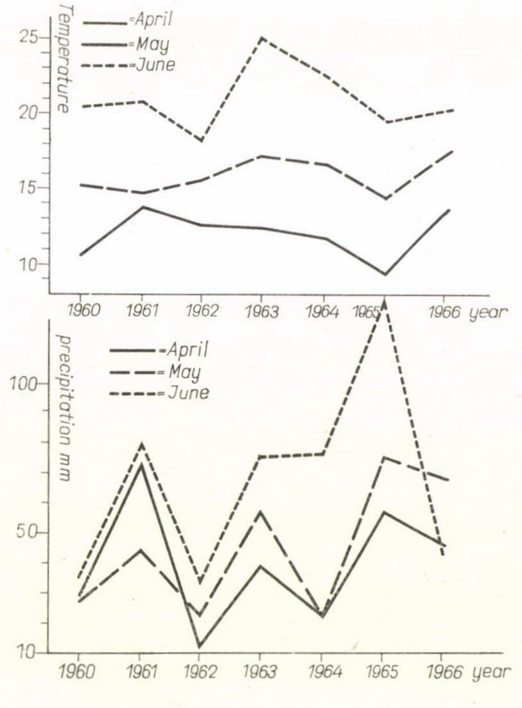


Fig. 3. Temperature and precipitation (April, May, June)

yield. The yield was high in 1961 and especially so in 1966. In the same years the dry weight contents proved to be low. Fig. 3 shows the temperature and precipitation values for the spring months (April, May, June) of the years 1960 to 1966. In 1965 the temperature was lower in all three months than in either the former or the following year. The years 1961, 1963 and 1964 were characterized by a fairly uniform, high temperature. The temperature in April was low in 1960 and 1965. The distribution of temperature is much more characteristic for the individual years. The amount of precipitation in the spring (April, May, June) of the years 1960, 1962 and 1964 was less than in other years. If the data of the graph are compared to those of Table 1 and Fig. 1

it is apparent that in these years the dry matter content was relatively high whereas the yield was low (Fig. 4). As shown by the data of Fig. 4 there is a surprisingly close connection between the average yields and average dry matter contents in all the experimental years since 1960. Accordingly in those years in which the yields were high the dry matter contents were low. In 1966 we had the highest yield and at the same time the lowest dry matter content.

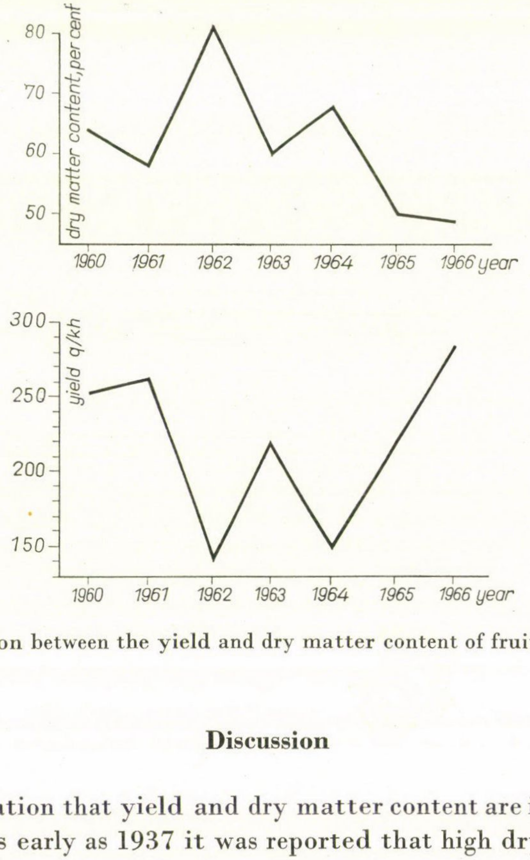


Fig. 4. Correlation between the yield and dry matter content of fruits in 1960—1966

Discussion

The observation that yield and dry matter content are inversely correlated is not new. As early as 1937 it was reported that high dry matter contents had often been accompanied by low yields (TAXNER *et al.* 1937). Of course, the opposite is also true, as shown by the data obtained for the last few years. What can be the reason for the dramatic decrease in dry matter content in the past few years? The varieties themselves cannot be responsible just as the high yield of 1966 cannot be attributed to the preponderance of any special variety. Although temperature and precipitation prevailing during the ripening period do not seem to influence dry matter content, yet, the decisive factor is to be sought for in climatic conditions. The temperature and precipitation of the spring months have been shown to be of an indirect effect on the quality of fruits. This means that the climatic conditions of spring allow us to draw certain conclusions as to the amount and the expected quality of the yield, e.g. its dry matter content.

REFERENCES

Bontovits, L. (1964): A paradicsom szárazanyagtartalom változásának gazdasági kihatásai (Economical Consequences of Changes in the Dry Matter Content of Tomato). Konzerv- és Paprikaipar, 151—154.

Bontovits, L. (1952): Paradicsomfajták szárazanyag-, cukor-, sav- és C-vitamin tartalmának alakulása az érés folyamán (Changes in the Dry Matter-, Sugar-, Acid- and Vitamin-C Contents of Tomato Varieties during the Ripening Period). Kert. Kut. Int. Évkönyve, 27—43. 1950.

Daskaloff, Chr.—Tarnovska, K.—Ognjanova, A. (1965): Qualitätssteigerung bei Tomaten auf dem Wege der entfernten Hybridisation. Zeitschrift für Pflanzenzüchtung, **53,** 189—196.

Flocker, W. Y.—Lingle, J. C.—Macgillivray, J. H.—Leonard, S. (1961): Quality Factors of Canning Tomatoes. Vegetable Crops, Series 111 University of California, Dawis, 1—10.

Jámbor, B.—Mészáros, L. (1951): Szegedkörnyéki gyümölcsök szárazanyagtartalma (The Dry Matter Content of Fruits Grown in Orchards near Szeged). Szegedi Mezőgazdasági Kísérleti Intézet Évkönyve, **1,** 97—111.

John, H.—Mac Gillivray—Clemente, L. J. (1956): Effect of Tomato Size on Solids Content. Proceedings of the American Society for Horticultural Science, **68,** 466—469.

Kovács, I. (1966): Adatok a paradicsom szárazanyagtartalmának alakulásáról a Kecskeméti Konzervgyárban (Contribution to the Changes in Dry Matter Content of Tomato in the Factory for Canned Products of Kecskemét). Personal communication.

Massey, D. M.—Winsor, G. W. (1956): The Composition of Tomato Fruit in Relation to Variety, State of Ripeness and Fruit Quality, Glasshouse Crops Research Institute, Annual Report 1956. Littlehampton Sussex 140. 52—64.

Mészöly, Gy. (1949): Paradicsom terméshozam és szárazanyag viszonya (The Correlation between Yield and Dry Matter Content of Tomato). Agrártud. Egy. Kert. és Szől. Karának közleményei, **13,** 3—29.

Mészöly, Gy. (1966): Gondolatok az idei paradicsomtermésről (Speculations about the Tomato Yield of this Year). Kertészet és Szőlészet, **21,** 3—4.

Rotonda, C. (1956): I problemi technoligici dell'industria conserviera ed il miglioramento genetico del pomodoro, Genetica Agraria, Pavia, **6,** 1—4. 353—370.

Rubin, B. A.—Metlickij, L. V. — Рубин, Б. А. — Метлицкий, Л. В. (1949): Проблема повышения содержания сухих веществ в плодах томата. Биохимия плодов и овощей. Москва. **149,** 85—112.

Samoggia, V. (1961): Osservazioni sperimentali su alcune caratteristiche qualitative del pomodoro. L'Agricultura Italia, Pisa, 1—18.

Silvestri, G.—Porcu, S. (1963): Prova di confronte varietale di pomodoro, Industria Conserve, Parma, **38,** 36—43.

Somos, A. (1959): A paradicsom (The Tomato). Akadémiai Kiadó, Budapest.

Szilágyi, T. (1963): Egyes időjárási tényezők hatása a paradicsom minőségére (Effect of certain Climatic Factors on the Quality of Tomato). Időjárás, **2,** 113—117.

Stojkov, S. A. — Стойков, С. А. (1954): Принос ком химичната и биохимичната характеристика на сока на най-застопинете у нас сортове домати. Научни Трудове Висж. Институт по Хранителна и Вкусова Промышленност. Пловдив. **276,** 71—82.

Taxner, K.—Benedek, L.—Zucker, F.—Csiba, L. (1937): Paradicsomtermesztési kísérletek (Trials of Tomato Production). Ed by: Osztróvszky Antal, Magyar Konzervgyárosok Országos Egyesülete, Budapest, 1—83.

Vidéki, L.—Bontovits, L. (1957): Beltartalmi veszteségek a paradicsom különböző tárolásánál (Losses in Reserve Substances during Different Ways of Storing Tomato). Élelm. Ip., **3—4,** 106—109.

Vidéki, L.—Báldy, B. (1964): Jelentés a bulgáriai tanulmányútról (Report on a Study Trip in Bulgaria) Kecskemét, Manuscript.

VIDÉKI, L.—SZEMES, S. (1966): Paradicsom szárazanyagtartalom meghatározási módszerek összehasonlítása (A Comparsion of some Methods Used for the Determination of the Dry Matter Content of Tomato). Kecskemét, Manuscript.

VLADIMIROV, B. — Владимиров, В. (1964): О закупках томатов в зависимости от содержания сухих веществ. Консервная и овощесушильная промышленность. **12**, 33—35.

WINSOR, G. W.—MASSEY, D. M. (1957): Studies of the Composition of Tomato Fruit. Glasshouse Crops Research Institute, Annual Report, Littlehampton, 161, 40—52.

YAMAGUCHI, M.—HOWARD, F. D., *et al.* (1960): Effect of Ripeness and Harvest Dates on the Quality and Composition of Fresh Canning Tomatoes. Proc. Amer. Soc. Hort. Sci. East Lansing, **76**, 560—567.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 405—410 (1968)

INHIBITION OF CO_2 FIXATION AND PROTEIN SYNTHESIS IN APPLE LEAVES INFECTED BY VENTURIA INAEQUALIS

By

Zs. Dancs, B. I. Pozsár, V. Ferencz

RESEARCH INSTITUTE FOR PLANT PROTECTION AND INSTITUTE OF SOIL RESEARCH AND AGROCHEMISTRY OF THE HUNGARIAN ACADEMY OF SCIENCES, BUDAPEST

The intensity of radioactive CO_2 fixation has been found to be much lower with apple leaves infected by *Venturia inaequalis* (Cke.) Wint. (30 to 40 per cent coverage) than with healthy ones. In infected leaves dark fixation has been inhibited to a much higher extent than either protein synthesis or photosynthetic CO_2 fixation. The biosynthesis of chlorophyll and carotenoid components has been inhibited upon infection at a similar rate as photosynthetic CO_2 fixation. The rate of incorporation of C^{14} labelled glycine into leaf protein (protein synthesis) has also been lower in infected tissues than in healthy ones. The decreased intensity of leaf pigment and protein synthesis is in close correlation with the reduction of photosynthetic activity as measured by the data of CO_2 fixation. The extensive inhibition of dark fixation results in a lowering of the intensity of the synthesis of organic acids, which may, in turn, inhibit cell respiration in an advanced stage of infection.

Introduction

In apple orchards, especially in rainy seasons, infection with *Venturia inaequalis* (Cke.) Wint., also called *Fusicladium*, causes great losses. The rate of infestation may give a coverage of the leaf surface as high as 30 to 40 per cent. Because of the injury of the leaf parenchyma fruit development may be impaired. Sometimes fruits are infected directly. In the year 1964—65 especially heavy infestations by the fungus were recorded from April to June in the counties Szabolcs-Szatmár and Zala. The above period is the most suitable season for the development of the fungus (Viennot—Bourgin 1949). An attempt was made to characterize the degree of injury of the leaves by physiological and biochemical data. To this end the rates of photosynthetic CO_2 fixation and of protein synthesis were determined in infected leaf tissues and compared to those of healthy ones. The results obtained from these experiments, carried out with labelled compounds, were used to give a rough quantitative estimate of the degree of injury caused by infection.

Materials and Methods

From healthy and fungus *(Venturia inaequalis)* infected apple *(Malus pumila* Mill.) leaves discs were punched out and arranged randomly. At the date of sampling the infection gave a 30 to 40 per cent coverage on the leaves and the fungus formed fully developed dark colonies. Samples taken at an advanced stage of infection were heavily damaged.

For the measurement of photosynthetic CO_2 fixation, carbon dioxide was liberated from ^{14}C labelled barium carbonate with lactic acid, using the method reported by ARNON (1961). The specific activity of the ^{14}C labelled barium carbonate was 130 mC/g, from which 120 μC were used in a 5 liter desiccator particularly designed for this purpose. In addition to dark fixation the intensity of light fixation was also determined with leaf discs illuminated with an electric bulb of 400 Watts for the experimental period of 15 minutes. After the exposition time radioactive carbon dioxide was removed from the gas space by a vacuum pump during 3 minutes. The discs were treated with ethyl alcohol to stop their metabolic activity and their radioactivity determined after homogenization. Soft beta rays were measured with a proportional gas flow counter as described in an earlier publication (POZSÁR—KIRÁLY 1966). Photosynthetic CO_2 fixation was calculated by subtracting the counts obtained with light fixation from those obtained with dark fixation. The CO_2 fixation experiments were repeated thrice with 5 parallels every time. In the Tables the counts per minute are given along with their standard deviations.

The chlorophyll content of healthy and infected apple leaves was estimated from 100 mg leaf tissues (fresh weight). Water content of the tissues was 67 per cent. The tissues were homogeniz ed in 2 ml of 80 per cent methyl alcohol. The mortars were washed with 2 ml and then with 1 ml of methyl alcohol. The homogenate and the two washing solutions were combined and centrifuged for 10 minutes at 4000 rpm. The sediment was washed once with 2 ml methylalcohol and twice with a 1 : 1 mixture (v/v) of ethylether and methyl alcohol. The original supernatant was combined with those obtained after the three washings. The combined solution was made up to 10 ml with methyl alcohol and its absorbancy read at 665 mμ in a Hilger spectrophotometer. The absorbancies are expressed in terms of absorbancy per 100 mg fresh weight. The intensity of photosynthetic CO_2 fixation expressing the potochemical activity of chlorophyll was calculated for 1 mg of chlorophyll with both healthy and infected leaves.

Chlorophyll biosynthesis was followed in isolated chlorophyll fractions by measuring the incorporation of ^{14}C labelled carbon dioxide after an exposition for 15 minutes. The two chlorophyll components were estimated together after being separated from the carotenoids by using an organic solvent system as described by HOLDEN (1965). The data of the incorporation experiments are expressed both as counts per minute, related to chlorophyll and carotenoid contents, respectively, and as specific activities (cpm/mg), together with the standard deviations.

Amino acid incorporation was estimated by OSBORNE's (1962) method and used to characterize protein synthesis. ^{14}C labelled glycine, which is known to incorporate into plant proteins at a high rate, was employed with a specific activity of 26 mC/mM. The discs were floated on 50 ml solution with an activity of 0.1 μC/ml for 4 hours. The data are expressed in counts per minute and calculated as the percentages of the control. Radioactivity was measured in a proportional gas flow counter. The deviation of results is given as standard deviation.

The amounts of some organic components of diseased leaves as well as the specific activities indicating the photochemical and biosynthetic activities of infected leaf tissues are expressed also as percentages of the healthy control tissues.

Results

Photosynthetic CO_2 fixation was calculated by subtracting the counts obtained with light fixation from those obtained with dark fixation and expressed in average cpm values. In a very advanced stage of infection and in the case of a coverage of 30 to 40 per cent of the leaf surface chlorophyll content decreased by 38 per cent whereas the rate of photosynthetic CO_2 fixation only by 23 per cent, as compared to the control. At the same time, as shown in Table 1, the rate of dark CO_2 fixation was reduced to a much higher extent (73 per cent) than that of light CO_2 fixation (58 per cent) upon infection. The ratios of CO_2 fixation (the value for healthy tissues divided by the value for infected tissues) were 2.3 for light fixation and 3.6 for dark fixation, indicating that the latter was affected by infection to a higher extent than the former.

Table 1

Effect of infection with Venturia inaequalis on the light, dark and photosynthetic fixation of C^{14} labelled carbon dioxide by apple leaves

Tissue	Carbon dioxide fixation						Chloro-phyll content mg/100 mg fresh weight	Specific activity cpm/mg chloro-phyll
	Light		Dark		Photosynthetic			
	cpm/100 mg fresh weight	S.D.	cpm/100 mg fresh weight	S.D.	cpm/100 mg fresh weight	S. D.		
Healthy	26 300	3400	6900	1100	19 400	2700	2.4	8082
Infected	11 300	2800	1900	600	9 400	1600	1.5	6266
Percentage inhibition caused by infection	—	—	—	—	—		38	23

The specific activities expressing the photochemical activity of the tissues show that although the chlorophyll content/fresh weight decreased upon infection, the relative photochemical activity slightly increased, since upon infection this value decreased to a much lesser extent.

As shown in Table 2, fungus infection has reduced the rate of the biosynthesis of chlorophyll components in addition to inhibiting photosynthetic CO_2 fixation. This is shown by the decrease of both chlorophyll level and specific activity. The inhibition of photosynthetic CO_2 fixation may be due indirectly to a reduction of the rate of chlorophyll biosynthesis. Chlorophyll biosynthesis has been shown to be inhibited by 32 per cent upon infection, as calculated from measuring specific activities. Photosynthetic CO_2 fixation, on the other hand, has been reduced only by 23 per cent, based on the specific activities obtained.

Table 3 represents the effect of infection on the biosynthesis of carotenoids as expressed by the carotenoid levels and the specific activities per mg. Fungus infection has resulted in a 32 per cent decrease in carotenoid content

Table 2

Effect of infection with Venturia inaequalis on the amount and biosynthesis of chlorophyll in apple leaves, upon administration of $C^{14}O_2$

Tissue	Chlorophyll			
	cpm/100 mg fresh weight	S.D.	mg/100 mg fresh weight	Specific activity cpm/mg chlorophyll
Healthy	1582	237	2.4	659
Infected	680	114	1.5	453
Percentage inhibition caused by infection	—	—	38	32

Table 3

Effect of infection with Venturia inaequalis on the amount and synthesis of carotenoids in apple leaves, upon administration of $C^{14}O_2$

Tissue	Carotenoids			
	cpm/100 mg fresh weight	S.D.	mg/100 mg fresh weight	Specific activity cpm/mg carotenoids
Healthy	1056	168	1.6	660
Infected	472	87	1.1	429
Percentage inhibition caused by infection	—	—	32	35

and in a 35 per cent reduction of specific activity, indicating an almost identical lowering of both carotenoid content and rate of carotenoid biosynthesis. Reduction of both chlorophyll and carotenoid levels and biosynthetic activities may be regarded as the immediate result of the irreversible desorganization of chloroplasts.

Table 4 shows that the rate of incorporation of C^{14} labelled glycine into leaf protein has been inhibited by 37 per cent upon infection, as calculated from radioactive measurements. This finding is the more unexpected, as the counts obtained with infected leaf tissues include those of the protein of the fungal mycelia as well. Since protein synthesis is the basic metabolic activity leading to the restoration of cell structures, its impairment may be the cause of the reduced photosynthetic activity of chloroplasts. Decreased rates of protein synthesis were found to occur only in a later stage of infection when a considerable necrotization of cell structures and tissues occurred.

Table 4

Effect of infection with Venturia inaequalis on the incorporation of C^{14} labelled glycine, into protein in apple leaves

Tissue	Protein			
	cpm/100 mg fresh weight	S.D.	mg/100 mg fresh weight	Specific activity cpm/mg protein
Healthy	2989	287	4.1	726
Infected	1887	213	3.8	496
Percentage inhibition caused by infection	—	—	5	32

The above mentioned 37 per cent reduction of the intensity of protein synthesis if compared to the values of 73 per cent and 58 per cent with dark fixation and light fixation, respectively, shows that disorganization of cell structure and functional inhibition was much more pronounced upon infection than repression of protein synthesis.

Discussion

The finding that infection with *Venturia inaequalis* results in an inhibition of the intensity of CO_2 fixation both in the dark and in the light and of the biosynthesis of leaf pigments (chlorophyll, carotenoids) is in a good agreement with LIVNE's (1964) results pointing to a reduced rate of photosynthetic CO_2 fixation upon infection. LIVNE—DALY (1962) as well as DALY—LIVNE (1966) have shown that in rust-infected bean and wheat leaves dark CO_2 fixation is reduced to a much higher extent than CO_2 fixation in the light. This indicates that carboxylation associated with dark fixation is also inhibited by infection to a considerable degree. The above authors have found that the biosynthesis of organic acids, which are known to arise through carboxylation, is also suppressed in infected tissues. The above results were obtained by incorporation experiments with $C^{14}O_2$ and were related to the inhibition of cellular respiration in advanced stages of disease development. The results presented in this paper point to a general inhibition of the whole metabolism of infected tissues, due to the suppression of photosynthetic CO_2 fixation and of the biosynthesis of chlorophyll and carotenoids.

In the early stages of the infection process, protein synthesis is enhanced in the host-parasite complex and labelled metabolites and photosynthetic products accumulated characteristically as shown by STAPLES—LEDBETTER (1958) as well as GERWITZ—DURBIN (1963). In infected leaf tissues during sporulation, the accumulation and the rate of incorporation of some metabolites is increased to an even higher extent as pointed out in an earlier paper (KIRÁLY—POZSÁR—EL HAMMADY 1966). On the other hand, in a later stage of infection characterized by an advanced tissue necrotization and a desintegration of cell structures, there is, at least in the apple-*Venturia inaequalis* host-parasite complex, a marked inhibition (32 per cent) of the rate of incorporation of labelled amino acids into proteins without an appreciable change in protein level.

The low intensity of protein synthesis in infected tissues as shown by incorporation experiments, may result in the desintegration of chloroplasts and of the cytoplasm due to the irreversible suppression of restitution processes. Inhibition of protein synthesis may be associated with the reduced rate of dark fixation of CO_2 in infected tissues.

According to the experimental results presented in this paper, infection of apple leaves with *Venturia inaequalis* results in a decreased intensity of protein and pigment (chlorophyll, carotenoids) synthesis and of photosynthetic CO_2 fixation. This suggests a general inhibition of biosynthetic processes in the necrotized tissues of the host parasite complex. It has to be emphasized that in later stages of infection dark fixation of carbon dioxide is inhibited to a much higher extent than photosynthetic CO_2 fixation, pointing to an excessive injury to the biosynthesis of organic acids. This is in agreement with the experimental results of DALY—LIVNE (1966) and LIVNE—DALY (1962).

REFERENCES

ARNON, D. I. (1961): Cell-free Photosynthesis and the EnergyConversion Process. In: W. D. MC ELROY and B. GLASS: Light and Life. J. HOPKINS Pr., Baltimore 489—566.

DALY, J. M.—LIVNE, A. (1966): Dark Fixation of Carbon Dioxide by Healthy and Rust-affected Leaves of Wheat and Bean. Phytopathology, **56,** 164—169.

GERWITZ, D. L.—DURBIN, R. D. (1963): The Effect of Bean Rust on the Foliar Uptake of P^{32}. Phytopathology, **53,** 876.

HOLDEN, M. (1956): Chlorophylls. In: T. W. GOODWIN: Chemistry and Biochemistry of Plant Pigments. Acad. Pr., New York 461—488.

KIRÁLY, Z.—POZSÁR, B. I.—EL HAMMADY, M. (1966): Cytokinin Activity in Rust-infected Plants: Juvenility and Senescence in Diseased Leaf Tissues. Acta Phytopathol. Hung., **1,** 29—37.

LIVNE, A. (1964): Photosynthesis in Healthy and Rust-affected Tissues. Plant Physiol., **39,** 614—621.

LIVNE, A.—DALY, J. M. (1962): CO_2-fixation in Healthy and Rust-affected Tissues. Phytopathology, **52,** 18.

OSBORNE, D. J. (1962): Effect of Kinetin on Protein and Nucleic Acid Metabolism in *Xanthium* Leaves During Senescence. Plant Physiol., **37,** 599—602.

POZSÁR, B. I.—KIRÁLY, Z. (1966): Inkorporation von verschiedenen radioaktiven Stoffen und TMV-Vermehrung in intakten Tabakblättern unter dem Einfluss von Kinetin und Adenin. Acta Bot. Acad. Sci. Hung., **12,** 95—110.

STAPLES, R. C.—LEDBETTER, M. C. (1958): A Study by Microradioautography of the Distribution of Tritium-labelled Glycine on Rusted Pinto Bean Leaves. Contr. Boyce Thompson Inst., **19,** 349—354.

VIENNOT-BOURGIN, G. (1949): Les champignons parasites des plantes cultivées. I. II. Univ. Pr. Paris.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 411—418 (1968)

DETERMINATION, WITH TETRAZOLIUM SALTS, OF THE VIABILITY OF WHEAT SEED INJURED BY METHYL BROMIDE

By

S. GÁSPÁR

STATE BOARD OF SEED CONTROL, BUDAPEST

The viability of wheat seed injured by methyl bromide cannot be determined with TTC (2,3,5-triphenyltetrazolium chloride) as also non-germinative embryos develop formazane due to their post-mortal dehydrogenase activity. In the course of storage the grains lose to a greater extent their germinating capacity than their dehydrogenase activity. Using INT (2-(iodophenyl)-3-(p-nitrophenyl)-5-phenyltetrazolium chloride) instead of TTC as indicator, a decreased germinative ability can be evinced. There exists a close correlation between the oxygen uptake of wheat embryos injured by methyl bromide and the quantity of INT-formazane per 1 g raw material, which is non-existing between the quantity of TTC formazane and the oxygen uptake. Because of the different behaviour of TTC and INT, their point of attack as supposed up till now to be on the terminal oxidation chain, may be found elsewhere, — or the terminal oxidation system differing from the cytochromes may play a role in the tansfer of electrons. Between the quantity of INT formazane produced for 1 g dry material by the embryos injured by methyl bromide and their germinative ability as well as their viability, a linear correlation has been established.

Nitro BT (2,2′di-p-nitrophenyl-5,5′diphenyl-3,3′-3,3′dimethoxy-4,4′diphenyl tetrazolium chloride) has not been found suitable as an indicator for determining the viability in wheat embryos.

Introduction

Methyl bromide is widely applied for disinfecting the seed. The use of the gas quantity prescribed does not interfere with the germinative ability of the seed, but in case of a larger quantity of gas used or the sacks of seed being placed near the gas source, the seed may be injured by methyl bromide. The damage suffered through methyl bromide causes the slackening or total vanishing of the germinative ability in the seed. Its rate can be evinced by way of the germinating test. However, when determining the viability of the seed with 2,3,5-triphenyltetrazolium chloride (TTC), the probable damage caused by methyl bromide cannot be proved reliably, and therefore, in such cases the use of TTC is not advised (GRABE 1959). In 1966, in our examinations of ten winter wheat samples, also a considerable difference proved to be between viability (seed potency) and germinating capacity. In order to study the problem more thoroughly, we examined, on available samples, how the germinating capacity injured by methyl bromide and the viability determined by TTC, changed in the course of storage. At the same time we tried to find a method for determining also with tetrazolium the rate of harm caused by methyl bromide.

Material and Method

For our experiments eight *Bezostaya 1* winter wheat samples damaged to different extent, have been used. During the experiment the samples were stored in the laboratory. The germinating capacity of the samples was determined from 4×100 grains on a filter-paper at 20° C, in the months IX, X, XII, of the year 1966 and in the months II, IV of the year 1967.

For the determination of viability a solution of 2,3,5-triphenyl-tetrazolium chloride (TTC) 1 per cent (2.99×10^{-3} mole) watery, 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyltetrazolium-chloride (INT) 10^{-3} mole and 2,2′ di- p- nitrophenyl-5,5′diphenyl-3,3′-3,3′dimethoxy-4,4'-biphenyl ditetrazolium chloride (Nitro BT) 10^{-3} mole watery solution containing 5 per-cent alcohol had been used. The solutions were set at pH 6.6 with KOH.

The determination of viability was performed in the following manner: The grains were swelled in water for 16 hours, then the embryo was taken off with the aid of a lance-needle and put into the suitable tetrazolium solution. The embryos were kept in the solution for 20 hours at 30° C and in dark.

In order to determine the quantity of formazane brought about by the embryos, these were kept — after having judged the viability — in 100° C water for 10 minutes partly to stop enzyme activity and partly to facilitate the dissolving of the formazane. From the embryos the formazane was extracted with acetone, then the extinction of solution was determined with MOM spectrophotometer at 480 μm with TTC, while in the case of INT this was made at 482 μm. The formazane production of the embryos as referred to 1 g embryo dry material, is given in mg.

The oxygen uptake of the embryos was determined by way of the Warburg technique in distilled water from 50—50 embryos at 30° C on the basis of 2—2 hours' measurings, at a swinging frequency of 90/min. A seed sample of *Bezostaya 1* was treated with a great portion of methyl bromide gas for 48 hours in order to examine whether in such case the tetrazolium indicated viability.

The results obtained in the course of our experiments have been evaluated statistically.

Results

The change of germinative ability and that of viability in the course of storing are shown in Table 1. From the Table it can be seen that between the germinative capacity and viability of seed samples injured by methyl bromide, there is, right after the damage, a great difference which shows that TTC can only indicate vaguely methyl bromide damage even if it is present in high degree. In the course of storage, germinating ability decreased to a greater extent than viability. In the average of the samples, as opposed to the 41 per cent decrease of germinative ability, that of viability determined with TTC, was but of 21 per cent. The activity of the dehydrogenase enzyme system decreases only slightly also in the course of storing. This is as well confirmed by the results submitted in Table 5. From this it can be seen that contrary to the germinative ability decreasing nearly to its one seventh, the TTC formazane production has decreased only by one third. That decrease of about 30 per cent cannot be possibly judged when evaluating visually the embryos because the colour intensity is smoothly decreasing in the whole of them.

The results shown in Table 2 prove that using INT instead of TTC when examining viability, the rate of damage done to the embryo could be traced and in such cases the per cent of viability values submitted was agreeing with the result gained at the examination of germinative ability.

Table 1

Change of germinative power and viability in winter wheat samples damaged by methyl bromide as established with TTC during 7 months of storage

Number of samples	Germinative power %					Viability % with TTC				
	1966			1967		1966			1967	
	IX.	X.	XII.	II.	IV.	IX	X.	XII.	II.	IV.
185	60	55	56	25	—	75	66	70	68	—
186	80	64	67	39	45	95	91	87	88	86
187	70	65	65	44	42	92	92	93	90	81
188	63	53	46	39	42	80	80	79	73	74
189	65	39	61	39	38	91	84	83	79	80
190	78	67	57	50	37	97	92	95	89	87
191	54	50	54	41	33	95	92	95	91	88
192	12	11	11	14	—	76	85	73	70	—

Table 2

Germinative ability and viability of methyl bromide-damaged wheat samples as determined with INT

Number of samples	Germinative ability %	Viability %	Germinative ability %	Viability %
	1967. February		1967. April	
185	25	33	—	—
186	39	45	45	51
187	44	48	42	52
188	39	33	42	32
189	39	40	38	38
190	50	59	37	46
191	41	20	33	44
192	14	18	—	—
Mean	48.5	49.3	39.5	43.8
$D_{1\%}$	±12.25%		±11.34%	

In our experiments the INT was used in a concentration of 10^{-3}mole partly because of its high price and partly because of its getting reduced easily, thus that concentration also produced suitable colour intensity for the evaluation of the embryos. In some samples the viability results obtained by applying the 10^{-3} and 1 per cent TTC solution were also compared, and it could be seen that they were agreeing (Table 3). However, the use of 10^{-3} mole TTC solution in practice is not advisable as a consequence of being — in that concentration-

Table 3

Viability of methyl bromide-damaged embryos incubated in 10^{-3} and 2.9×10^{-3} TTC solution

Number of samples	10^{-3} m TTC	2.9×10^{-3} m TTC
185	68	68
188	81	73
192	70	70
Mean	73	70.3
$D_1\%$		± 10.02

small the bactericidal effect and during the relatively long incubation time, an infection may easily deposit formazane which will disturb determination. The INT in 10^{-3} mole concentration has still bactericidal effect, however, a solution thinner than 5×10^{-4} mole concentration is not advised either in that material.

After having treated the methyl-damaged embryos with INT, if the methyl content was entirely lethal, they are of white colour similarly to those experienced in case of TTC solution. If the damage was less, but it still hindered the normal development of the embryo, their colour ranged from pale-pink to dark-pink. The plumule was speckled with white or pale-pink spots. The scutellum either got entirely wilted or showed hardly any activity. In general, the decaying of tissues started along the seed-coat and it reached in many cases only to the coleoptyl or coleorhize. However, this damage proved to be right enough to arrest the embryo's development at its start or, after some initial growth to cause it to die.

When treating wheat seeds with a lethal quantity of methyl bromide gas, they lose, together with their germinative ability, all their dehydrogenase activity as well. In such cases post mortal activity could not be evinced either with TTC or with INT (Table 4).

Table 4

Viability of wheat seeds treated with a large quantity of methyl bromide gas or left untreated, — determined with TTC and INT as well as the germinative capacity of the seeds

Treatment	Viability %		Germinating ability %
	10^{-3} m TTC	10^{-3} m INT	
Control	95	94	93
Treated with methyl bromide	1	—	—

When incubating the methyl bromide-damaged embryos in TTC, between the quantity of TTC-formazane developing per 1 g embryo dry material and the germinative capacity of samples no linear correlation can be found (Table 5). If the embryos are incubated in INT, between the mg quantity of

Table 5

The rate of O_2 consumption and formazane production for 1 g embryo dry material in the case of methyl bromide-damaged and untreated wheat seeds. (O_3 consumption during 2 hours at 30° C)

Number of treatment	O_2 µl	Control in %	TTC formazane mg	Control in %	INT formazane, mg	Control in %	Germinative power %	Control in %
Control	894.2	100.00	68.59	100.00	17.94	100.00	93	100.00
184	573.9	64.18	66.83	97.43	9.71	54.10	57	72.04
192	270.9	30.29	47.79	69.66	4.28	23.80	14	15.05

formazane produced by the embryos for 1 g dry material and the germinating ability linear correlation can be established (Fig. 1). However, the correlation is significant at the level P = 1 per cent. Between the mg formazane quantity and viability the linearity is closer and is significant even at P = 0.1 per cent.

For the determination of viability the Nitro BT was not found to be suitable. A wheat seed sample with 93 per cent germinative ability showed

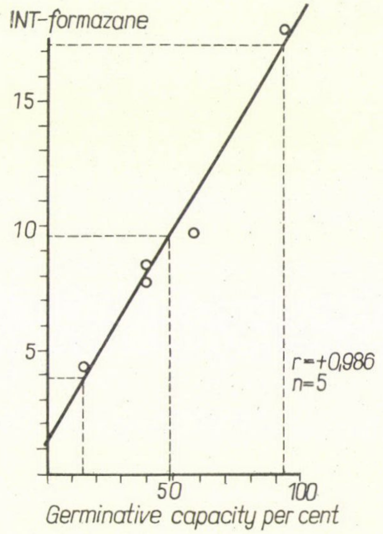


Fig. 1. Correlation between the quantity of INT-formazane for 1 g embryo-dry material in wheat seeds injured by methyl bromide and their germinative capacity

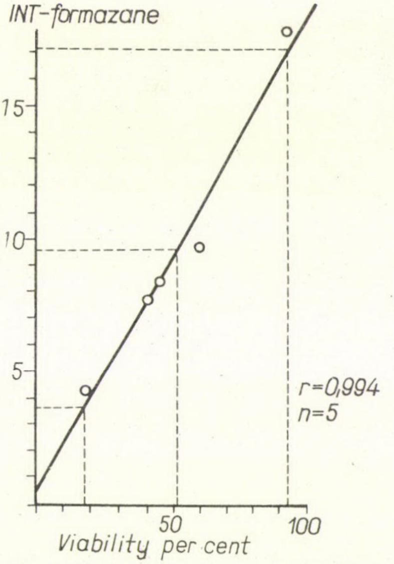


Fig. 2. Correlation between the INT-formazane quantity for 1 g embryo-dry material in wheat seeds injured by methyl bromide and their viability

that even after 20 hours' incubation, only the root-initiative got coloured intensively. On most embryos the shoot did not get coloured at all. It is not possible to extract the developed formazane from the tissue and thus neither can its amount be determined quantitatively.

Discussion

The great percentile difference existing between the germinative ability of seeds damaged by methyl bromide and the viability determined by TTC, is mostly due to the fact that TTC shows also those embryos to be viable that, in the course of germinating, just start to develop; later, however, due to methyl damage, they are either killed or remain quite underdeveloped. At the end of germination these are considered as diseased since no healthy plant can develop from them. On the embryos developed from damaged seeds, once the resistance being weakened, the microorganisms will breed rapidly which also contributes to poor germinating capacity.

In case of embryos damaged by methyl bromide the formazane reaction might be the result of the fact that the enzyme-system accomplishing the TTC reduction, is hardly or not at all interfered with methyl bromide; at the same time it exerts great influence on the activity of several enzyme-systems determining germination.

When using INT as indicator instead of TTC, the damaged, non-viable embryos could be recognized, and viability agreed with the germinative capac ity. On the embryos it could be traced, even topographically that the methyl bromide gas penetrated through the fruit and the seed-coat, and where and to what extent had hindered the life-function of certain tissue-parts. With embryos whose shoot-coat had partly died, the initial leaves being underneath, became entirely coloured or only the parts being in contact with the bud-coat were killed. This was only too sufficient for the embryo to lose its vigour to such an extent that made it unable to develop the shoot and the roots.

As mentioned previously, the majority of the embryos damaged by methyl bromide, showed some signs of development in the first three days of germination. Being, however, the scutum of the bud also damaged, the contact existing between the embryo and the endospermium was interrupted and thus, the scutum could not perform its function.

Injured by methyl bromide and incubated in INT, the scutum of the bud, parallel to the rate of damage, grew lighter or darker pink in colour.

When incubating the injured embryos in TTC, the scutum of the bud was stained with a vivid red colour in each case and therefore, the damage done to the scutum could not be observed.

The linear correlation obtained between the rate of formazane formation as well as the germinative ability (Fig. 1) and viability (Fig. 2) support the author's opinion according to which in the course of viability examinations, the topographical evaluation of necroses in the embryo, together with its colour intensity, should be taken into consideration.

Incipient nekrosis or, as MOORE (1962) calls it: "decaying" is to be identified on the grain the embryo of which does not yet reveal the necrosis of places that can be separated topographically, but they do show some activity while they inhibit the development of the plant.

Similar statement was made by RICE (1959) when examining the grain of maize. He used also INT with the maize. In the case of wheat grains damaged by methyl, GRABE (1959) tested some tetrazolium derivatives — among them INT —, but with each derivative he obtained higher viability than the germinative capacity.

According to author's opinion, the cause of failure was that he seemed to disregard the colour intensity of the embryo. Most probably, methyl bromide decreases the germinative capacity because it partly inhibits the terminal oxidation. According to LEWIS (1948) the methyl bromide inhibits the succinic acid dehydrogenase enzyme activity. As it can be seen from the data of Table 5, the oxygen uptake of embryos damaged by methyl bromide, decreased with the decline of germinative ability, but the correlation between the oxygen uptake and the change of germinating capacity was loose ($r = + 0.295$). The correlation between oxygen uptake and the quantity of INT produced for 1 g embryo dry material, was very close ($r = + 0.995$). At the same time between the quantity of TTC formazane and the oxygen uptake no correlation could be noticed since methyl bromide had inhibited the oxygen consumption in 70 per cent and the reduction of TTC to formazane in 30 per cent only. Thus, it seems that the dehydrogenase system which reduces the molecules of TTC, shows post mortal dehydrogenase activity also in the case of methyl bromide damage. This is similar to the case when the wheat, barley and maize grains damaged by the too high temperature of artificial drying or treating with warm water lose their germinative capacity while with TTC they produce formazane reaction (BETHMANN 1956, KIETREIBER 1958, GERDES 1961).

As seen in the precedings, the INT formazane production is in close relation with the oxygen uptake of the embryos while TTC gives higher results. That behaviour of TTC and INT is all the more inexplicable as the point of attack of INT is presumed to be on cytochrome *b* while that of TTC on the cytochrome oxidase (cyt a_3) (BARKA—ANDERSON 1963). However, concerning the point of attack of TTC, no uniform opinion has been made, since SCHUBERT (1957) suggests that it is on cytochrome *c*. But recently the cytochrome *c* in plants is not supposed to be the component of the respiration chain (LIEBERMAN—BAKER 1965). If INT gets linked to cytochrome *b*, which is by some steps before cytochrome a_3, — then what inhibits the activity of cytochrome *b* ought to inhibit, at least to the same extent, cytochrome a_3 as well. On the other hand, the reaction of TTC with cytochrome a_3 is not essentially inhibited (Table 5), while the reaction of the embryo with O_2 is not considerable. For the unlike behaviour of TTC and INT the only explanation can be that the point of attack of TTC and INT as known in literature, does not square with the facts. It might also be possible that a terminal oxydase system, different from the cytochromes plays a role in the transfer of the electrons.

It has been tried to control the results obtained with INT, with the aid of Nitro BT since the point of attack of Nitro BT is also supposed to be on cytochrome *b* (BARKA—ANDERSON 1963). Unfortunately, Nitro BT has produced colour reaction only at the initial spot of root while, on the other hand, the intact hull and the initial foliage-leaves have not been stained. Having cut the shoot-hull in its length, somewhat better staining was obtained, however, this was not suitable either. The different staining of the shoot-hull and the initial root might be the result of the fact that, due to the relatively big molecule of the ditetrazolium, it cannot penetrate up to the place of reaction through the cytoplasmatic membranes of the shoot-hull cells; or the two positive chargings might also inhibit its entering the cell membrane of the living cell.

REFERENCES

BARKA, T.—ANDERSON, P. J. (1963): Histochemistry. Harper and Row, New York. 296—318.

BETHMANN, W. (1956): Zur biochemischen Keimprüfung. Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin, Sitzungsberichte, Leipzig, 1—32.

GERDES, G. (1961): Der diagnostische und prognostische Wert des topographischen Tetrazolium-Verfahrens bei unbehandeltem, behandeltem und überlagertem Saatgut von Gerste *(Hordeum vulgare* L.) und Mais *(Zea mays* L.). Eingereicht als Habilitationsschrift an der Landwirtschaftlichen Fakultät der Karl Marx-Universität Leipzig. 209.

GRABE, DON F. (1959): Preliminary Evaluations of Tetrazolium Derivatives for Testing Seed Viability. Proc. Ass. Seed Anal., **49,** 122—130.

KIETREIBER, M. (1958): Hitzeschädigungen bei Mais und der Tetrazolium Test. Jahrbuch 1957 der Bundesanstalt für Pflanzenbau und Samenprüfung in Wien. 9. Sonderheft (September 1958). 33—38.

LEWIS, J. H. (1948): Biol. Chem., **161,** 692.

LIEBERMAN, M.—BAKER, J. E. (1965): Respiratory Electron Transport. A. Rev. P. Phys., **16,** 343—382.

MOORE, R. P. (1963): The Dying Seed. Proc. Ass. Off. Seed Anal., **53,** 190—193.

RICE, J. C. (1959): Evaluation of Seed Vigor in Corn with Tetrazolium as Compared with Other Methods. Ph. D. Thesis, University Library, Miss. State University. State College. Missisipi.

SCHUBERT, J. (1961): Zur Bedeutung des Aciditätsgrades bei der Qualitätsbeurteilung von Saatgut nach dem topographischen Tetrazoliumverfahren. Saatgutwirtschaft. 3—4.

SVÁB, J. (1961): Statisztikai módszerek mezőgazdasági kutatók számára (Statistical Methods for Agricultural Researchers). Mezőgazdasági Kiadó, Budapest.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 419—430 (1968)

A NEW CHEMICAL WEEDING METHOD APPLIED TO LARGE-SCALE VINEYARDS PLANTED IN WIDE ROWS: THE SPRAY IRRIGATION IN STRIPS

By

Á. Kiss

AGROCHEMICAL LABORATORY OF THE STATE FARM, MÓR

In 1966 the author performed weeding experiments in large-spaced vineyards planted according to the Lenz Moser high cordon system. He used partly Hungarian-made herbicides suitable also for vine plantations, and partly chemicals of one and more components produced by the Geigy concern (Switzerland) for controlling weeds in vineyards. Contrary to traditional procedures these herbicides were applied according to large-scale methods practicable in vineyards and by operating the S-392 spraying device mounted on the RS-09 Maulwurf tractor. The area remained practically free of weeds for the whole year.

Introduction

In wide-spaced vineyards planted in broad strips (e.g. according to the Lenz Moser high cordon system) the soil of the space between two rows is cultivated with heavy-duty machines, mechanical methods. In the course of mechanical cultivation the loosening of the soil between the rows and the mechanical weeding is carried out with ploughs, cultivators, rotary hoes, disc- and spike-toothed harrows, etc. However, as to full utilization of the area, the mechanical cultivation of the spaces is limited, because on both sides of the rows a strip of 50 to 70 cm (altogether 100 to 140 cm) width remains uncultivated. It is customary to plant also sward artificially on these so called "weed stretches", if adequate conditions (possibilities of irrigation, etc.) prevail. In vineyards of the mountains and hilly regions this is virtually out of question, and without irrigation we have to reckon with the fact that the sward strips become parched and other, chiefly dicotyledonous weeds dominant. Stoloniferous species: *Agropyron*, *Cynodon*, *Calamagrostis*, etc. are the most characteristic and simultaneously most dangerous weeds. But also dicotyledonous weeds proliferate vigorously, producing exceedingly large masses every year. Frequently the weed stretches are mowed or reaped. But rentability is the precondition of both operations, i.e. they are carried out only when the stretches yield large weed masses by mowing and reaping. With their vigorous development the weeds overshade the foliage even of high cordon branches, increasing thus the intensive spread of fungal damages. In addition, weeds deprive vine of large amounts of nutrients. In most cases it is more complicated and difficult to perform a labour process of mowing or reaping than to hack and scuffle in due time. Hungarian and foreign research workers have conducted a great deal of useful experiments in the last decade. But as to the application of chemicals no modern methods have been practiced in the weeding of vineyards, which could be compared with the chemical procedures against segetal weeds in field growing of plants. The technique of applying herbicides in vineyards came — so to say — to a deadlock with low-duty knapsack sprayers.

On the basis of experience drawn from many thousand experiments several herbicides are considered to be suitable for weed control in vineyards. BRANAS (1960), in his work, reported on the application of systemic chemicals. FARHADI (1963) examined the weed killing effect of Triazin derivatives and other herbicides in irrigated vine plantations and found out that Triazin in doses of 12 kg per hectare freed the vineyard soil from weeds for the whole vegetational period. It was experimentally established by GAST (1960) that using sprays, that contained Simazin in doses exceeding 20 kg per hectare, only temporary yellowing of vine leaves was observed. GEIGY (1960) has marketed some dozens of weedicides for vineyards so far. From his most modern produces combinations containing Triazin, Amitrol, CMPP etc. as components have proved to be very effective in Hungarian experiments (KISS 1965, 1967). The most satisfactory application method of the Hungarian-made chemicals Hungazin-PK and Hungazin-DT in vineyards and on different soils using doses of 9 to 15 kg/ha was clarified by HEGEDÜS (1966) in the course of his many-year experiments. The recent combinations of GEIGY are ranged with the adequate vine-herbicides by STALDER—BARBEN (1965) as well. UBRIZSY (1962), evaluating the weed killing results obtained in Hungarian vineyards so far, drew the attention to Hungazin-PK and Hungazin-DT, containing inland agents, as well as to the combination Hungazin-DT + Aminotriazol.

Material and Method

In 1966 large-scale chemical weeding experiments were started by the author in wide-row vineyards planted according to the LENZ MOSER high cordon system. The experiments were carried out in stands of the vine varieties *Ezerjó* and *Welshrisling* in the *Koronahegy* area of the Mór vine-district, partly with GEIGY-made herbicides and their combinations respectively, on sample plots of 1 cadastral yoke (= kh = 0.575 ha.) and partly with the home-made Hungazin-PK and Hungazin-DT on sample plots of 5.75 ha each. The combinations of GEIGY (1966) were applied in doses of 8 kg/kh, while the inland produces in doses of 7 kg/kh.

The soil of the experimental area consists chiefly of lime-coated chernosem developed on loess, Pannonian sand, Pannonian clay, while for the minor part of marl and Oligocene sediment containing spots of abraded river gravel. The most important data of soil examination are presented in Table 1.

GEIGY-made herbicides used in the experiments:
1. *Gesatop* (Simazin) A-384
2. *Gesaprim* (Atrazin) A-1294

3. *Saminol* A-1089 (18 per cent Simazin + 34 per cent Amitrol)
4. *Campaprim* A-1544 (18 per cent Atrazin + 34 per cent Amitrol)
5. *Semparol* A-1164 (30 per cent Atrazin + 11.5 per cent CMPP + 5.2 per cent 2,4,5-T)
6. A-2086 (20 per cent Simazin + 38 per cent Amitrol + 16 per cent MCPA)
7. A-2067 (?)

Part of the enumerated chemicals (the produces Nos 1, 2, 3, 5) were already tested in traditionally minor-spaced vine plantations in previous years (Kiss 1965).

While in chemical weeding of minor-spaced, traditionally cultivated bearing vines, so to say, exclusively the low-duty knapsack sprayers can be used, in large-spaced systems planted

Table 1

Some important physico-chemical properties of the soil in the experimental area
Average data from three sample plots

Depth	Porosity	Stickiness according to Arany	Capillary water raising	Water-holding capacity	pH	Total Ca	Physiol. Ca	Humus	Total salt
cm.	P %		mm/5 h	%		content (%)			
20	34	32	450	17	7.0	22	27	2.8	0.10
50	34	30	470	17	7.2	23	25	2.6	0.15
100	33	35	310	18	7.2	20	24	0.7	0.18
150	33	38	295	20	7.2	25	28	traces	0.20

with a row-distance over 160 cm the application of the herbicides can also be carried out with heavy-duty machines.

Literature data on this field are not available. The theoretical problems on the possibilities of chemical weeding in wide-row vineyards of mechanical cultivation have already been studied in the Mór State Farm and the practical experiences gained are summarized as follows.

In large-spaced vineyards, for mechanical spraying device used for the treating of high cordon branches and mounted on the RS-09 Maulwurf tractor as well as the spraying direction of the nozzles must be changed so that at convenient angles (45 to 50°) 2 nozzles are mounted on the right and 2 on the left side, levelling them at the soil and the vine-rows respectively. Doing so, by operating the 2 + 2 nozzles the whole width of the mechanically uncultivable 100 to 140 cm broad weed stretch becomes covered with herbicides. The automatic nozzles are flexibly mounted to a vertical frame and form the spray drops hydraulically, without the help of compressed air. For producing drops beside nozzles of the cross-gap and liquid-impact type those of the baffle-plate system prove increasingly to be suitable. The most important structural elements of drop forming are:

a) the spray tank and mixing device,
b) the pump system and,
c) the spraying equipments.

The conceptual sketch of the spray irrigation in strips is shown by Fig. 1, while the labour process by Fig. 2. The work can also be performed with other adequate heavy-duty spray-frame sprinklers e.g. "Rapidtox-S".

In the cultivation of large-spaced vineyards (planted with 3 m row-distance) the third part of the whole area cannot be cultivated with machines, accordingly in an estate of 1000 kh. for an area of about 300 kh. hand-operated farming must be considered.

In the course of the experiments the above mentioned doses were suspended in 600 litres of water, and also 0.2 per cent of "Multifilm" surface-active substance was added to it. The herbicides were sprayed on wet soil surface, immediately before budding, in April 16 to 20. The middle row was left untreated as control in each plot.

The changes of weed cover, fluctuating between 8 and 15 per cent during the treatments, are shown in Fig. 3, while Table 2 presents the most important meteorological data of the evaluation period.

Table 2

Most important meteorological data of the evaluation periods of the experiment in 1966

Moth	Precipitation	Monthly averages of		
		atmospheric	soil	atmospheric humidity
		temperature		
	mm	C°		%
March	43.8	6.3	5.2	91
April	68.3	12.1	8.8	83
May	108.6	14.6	14.4	86
June	110.7	17.9	22.0	85
July	92.1	18.3	23.0	89
August	60.0	19.0	25.0	72
September	3.9	16.0	18.4	84
October	57.3	17.4	19.8	85

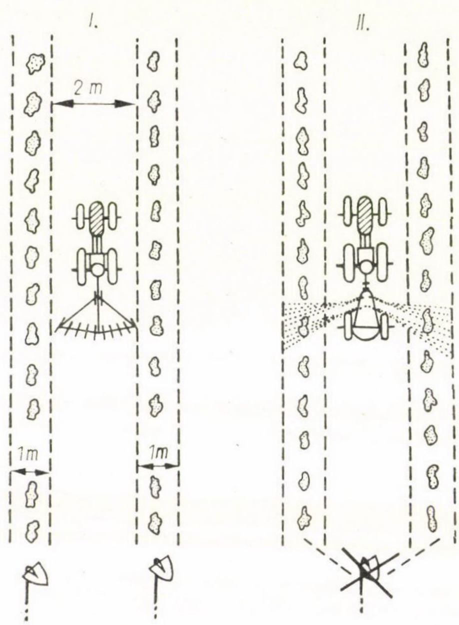


Fig. 1. Conceptual sketch (according to KISS) of the chemical weeding performed with spray irrigation in strips in large-scale vineyards. I. shows the principle of mechanical tilling between the rows. On both sides of the rows a weed stretch 1.0 to 1.4 m wide needs cultivation by hand. II. displays the conceptual sketch of chemical weeding performed with spray irrigation in strips

Fig. 2. The S-392 strip-spraying device, mounted on the RS-09 Maulwurf tractor, during work

Fig. 3. The weed cover in the period of treatments

The experiments were evaluated according to the following points of view: 1. Weed cover conditions in the period of treatments, the so-called "start-value". 2. Changes in the weed flora and its aspects, as well as in the cover degree (per cent) and amount of weeds on the treated and untreated plots. 3. Damages to the foliage. 4. Duration of the chemical effect. 5. Influence of the herbicides on fruiting.

Results

1. In the days of spraying the degree of weed cover fluctuated between 8 and 15 per cent. The following weed species were found as most characteristic for the spring aspect: *Holosteum umbellatum*, *Stellaria media*, *Lamium amplexicaule*, *Capsella bursa-pastoris*, *Veronica praecox*, *V. hederaefolia*, *V. triphyllos*, *V. serpyllifolia*, *V. polita*, *V. persica*, *Sisymbrium sophia*, *Erigeron canadensis*, *Lolium perenne*, *Polygonum aviculare*, *Senecio vulgaris*, *Cardaria (Lepidium) draba*, *Taraxacum officinale*, *Arthemisia vulgaris*, *Amaranthus retroflexus*, *Chenopodium album*.

From these species the first 10 of the enumaration were already flowering during the treatments, the others showed different stages of development.

2. In the period of experiments the most characteristic weed coenoses of cultivated land were as follows: *Amarantho-Chenopodietum albi* (Soó 1947), *Cardaria draba-Lathyrus tuberosus* (Kiss 1962), *Lactucetum salignae* (Ubrizsy

Fig. 4. Some characteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in September; the plots are free of weeds

Fig. 5. Some characteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in September; the plots are free of weeds

Fig. 6. Some characteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in September; the plots are free of weeds

Fig. 7. Some chracteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in Septemker; the plots are free of weeds

Fig. 8. Some characteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in September; the plots are free of weeds

Fig. 9. Some characteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in September; the plots are free of weeds

Fig. 10. Some characteristic pictures of the sample plots strip-sprayed with different herbicides demonstrate the state in September; the plots are free of weeds

1949), *Agropyretum repentis* (Felföldy 1942), *Convolvulo-Portulacetum oleraceae* (Ubrizsy 1949), *Echinochloo-Tussilaginetum* (Kiss 1965).

The changes in the number, mass and cover degree of weeds on the treated and control plots are summarized in Table 3.

3. *Gesatop* A-384 and *Gesaprim* A-1294 caused slight chlorotic symptoms during the whole year.

4. Investigations on the effect length and the period elapsing till inertness of the chemicals proved that in all experimental series the breakdown of the Geigy produces — exclusive of those mentioned under item 3 — could be demonstrated. The home-made Hungazin-PK and Hungazin-DT showed behaviour similar to that of both herbicides mentioned under item 3. Except these four chemicals neither of the others exerted an adverse effect on the test plants (spring-barley, oat, mustard, etc.) sown in any plot, all of them came to full development and ripened even seeds.

5. Investigations on fruiting revealed, that no damage had been done by the herbicides applied. This establishment was also confirmed by comparative examination on must fermentation.

Table 3

Changes of the weed cover and weed mass on the treated and control plots in experiments carried out

Herbicides	Dates of											
	May 16						June 16					
	Treated			Control			Treated			Control		
	1	2	3	1	2	3	1	2	3	1	2	3
Gesatop	0	0	0	25	220	24	3	9	4	28	243	31
Gesaprim	1	4	2	15	131	18	5	11	6	21	175	23
Saminol	1	3	0.6	18	82	13	1	4	1.1	27	111	17
Campaprim	1	4	0.8	12	23	7	0	0	0	19	47	11
Semparol	2	9	1	23	130	16	0	0	0	32	149	21
A-2086	3	14	3.4	31	215	25	4	20	2.9	41	311	29
A-2067	4	12	3.1	15	67	12	3	16	3.3	37	76	17
Hungazin-PK	1	5	4	11	22	16	6	14	5	22	144	21
Hungazin-DT	0	0	1	18	141	17	4	10	5	25	153	22

Symbols: 1 = number of weeds per square metre

Discussion

Under the above detailed soil and weed vegetational conditions nearly all chemicals has acted favourably. In the valuation of the herbicides it is considered as important, what amount of hacking can be saved by the chemical treatments. Hacking is usually applied, if the degree of weed cover reaches 20 to 25 to 30 per cent. On the treated plots this rate was not observed in November either, whereas all control plots approached a 100 per cent weed cover producing 5 to 6 kg weed masses per square metre.

Comparing the results it turns out that out of GEIGY's herbicide combinations *Saminol* A-1089, *Campaprim* A-1544 and *Semparol* A-1164 have proved to be most satisfactory. These chemicals are followed by the home-made Hungazin-PK and Hungazin-DT and subsequently by the other produces.

In the literature some erraneous publications may be found, according to which *Semparol* should be sprayed in vineyards after fruit setting. This false opinion lacks any foundation. The best time for the application of all herbicides and their combinations respectively tested in the experiments was the stage immediately before the opening of vine plants. Most of the combinations contain components which, if spraying is carried out in the vegetational period, induce so-called "blistering" (similar to that caused by nettle on human skin) and phytotoxic depression on the shoot system. On the other hand, the use of the above mentioned herbicides is advantageous, because they suppress *in 1966 with spray irrigation in strips.* (Averages of surveys replicated four times)

surveying																	
July 16						August 16						September 16					
Treated			Control			Treated			Control			Treated			Control		
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
7	14	5	34	329	55	8	26	7	37	763	68	8	31	13.6	41	3537	95
9	17	6	25	296	37	9	24	8	39	596	46	6	26	11.2	49	4396	98
2	9	1.2	54	217	29	1	5	3	58	427	53	3	12	3.1	59	5781	96
2	6	1.4	62	138	22	1	4	2	71	536	46	2	8	3.3	77	5937	87
1	4	0.7	45	221	41	1	3	0.9	48	647	61	3	15	2.0	53	4648	92
3	18	5.1	48	543	38	4	19	6	63	893	55	10	27	9.6	65	5897	95
4	21	6	39	217	31	6	28	7.9	45	751	57	17	35	13.9	51	4365	98
7	16	6	29	214	43	7	21	9	36	424	51	9	28	10.0	42	3114	91
7	15	6	34	189	28	9	20	7	41	575	55	10	28	11.5	54	5643	96

2 = weight of weeds in grams per square metre
3 = degree of weed cover in per cent

entirely *Convolvulus arvensis*, the most important vine weed, so that the "selected Convolvuletum", consisting exclusively of this species cannot develop, as it is known to happen in consequence of applying chemicals of the Triazin type.

The introduction of the large-scale spray irrigation in strip permits a profitable vine cultivation and eliminates the hand-operated tilling, an obstacle in large-scale farming. In addition, this solution does not hinder the green manure production, it is effective, and decreases the costs of chemical weeding to about the ninth of those needed by other methods.

The weed cover of the treated and control plots in September is shown by Figs 4 to 10.

Acknowledgements

Thanks are due to the Director of the Mór State Farm for the permission to carry out the experiments, and to the compliant technicians of the machine shop for their help in the solution of technical problems.

The author is indebted also to the Budapest Chemical Works and to the Geigy concern (Basel) for placing part of the chemicals at his disposal.

REFERENCES

Branas, J. (1960): Les télétoxiques. IV. Herbicides. — Progr. Agric. Vitic., **77,** 5—10.

Farhadi, I. — ФАРХАДИ, И. (1963): Гербициды на орошаемых виноградниках. Вин и Виногр. СССР. **23,** 42—44.

GAST, A. (1960): Neuere Erfahrungen mit Simazin im Rebbau. — Schw. Z. Obst- u. Weinb., **69**, 203—210.

GEIGY, S. A. (1966): Departement Schädlingsbekämpfung. Herbizid-Versuchsprogramm. Basel.

HEGEDÜS, Á. (1966): A Hungazin gyomirtó legmegfelelőbb alkalmazási módja a szőlőben. SzKI. és a 40. sz. főfeladat koordináló bizottsága közös közleményei (The most Convenient Application Method of the Hungazin herbicide in Vineyards. Common publication of the commission for the co-ordination of the work of the Research Institute for Viticulture with the main task No. 40). Szőlő- és Gyümölcstermesztés, Budapest, **1**, 5—58.

KISS, Á. (1967): Nagyüzemi szőlőgyomirtási kísérletek egy és több komponensű GEIGY-gyártmányú herbicidekkel (Large-scale Weeding Experiments in Vineyards with GEIGY-made Herbicides Consisting of one and more Components). In press.

KISS, Á. (1965): Újabb eredmények a szőlőgyomok vegyszeres irtásában (Recent Results in the Chemical Control of Weeds in Vineyards). Növényvédelem, **1**, 34—43.

KISS, Á. (1966): Újítási javaslat szőlőkben használt herbicidek nagyüzemi kijuttatására széles-soros (LENZ MOSER és kordon) ültetvényekben, gépi sávpermetezéssel (Innovation Suggestion Pertaining to the Large-scale Application of Herbicides in Vineyards Planted with Wide Rows (according to the LENZ MOSER and Cordon System) and Using the Mechanical Method of Spray Irrigation in Strips). Móri Állami Gazdaság.

STALDER, L.—BARBEN, E. (1965): Die chemische Unkrautbekämpfung im stark verunkrauteten Rebberg. Schw. Z. Obst- u. Weinb., **102**, 1—12.

UBRIZSY, G. (1962): Vegyszeres gyomirtás (Chemical Weeding). Budapest, Mezőgazdasági Kiadó, 348—358.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 431—449 (1968)

VARIA

KECSKEMÉT H RYE

(Kecskeméti H rozs)

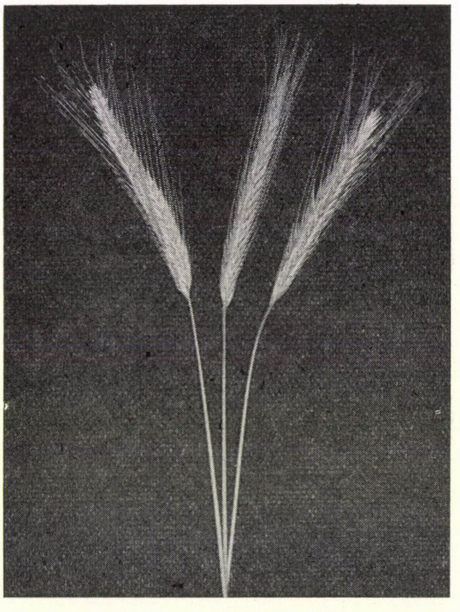


Fig. 1

Systematical place: *Secale cereale* L. ssp. *cereale* Zhuk. var. *vulgare* Kcke.

Origin: produced by the free crossing of Petkus rye with several varieties.

Beginning of breeding: 1950, Kecskemét.

Breeder: Ferenc Bauer, Agricultural Research Institute of the Region between the rivers Danube and Tisza, Kecskemét.

State qualification: Preliminary certified improved variety (KAPÁS *et al.* 1965), 1959.

General characterization: late-maturing variety of excellent winterhardiness and fairly good dry resistance; especially at the time of maturing it is sensitive to heat. On chalky-sandy soil it is high-yielding, the seeds being of rich protein content (KAPÁS *et al.* 1965).

Morphological description:

Root system: its delicately developed root system penetrates into the soil as deep as 100—120 cm.

Shoot system: mediocre tillering (average number of shoots is 4.3); the productive tillering shows 341—348 ears per m^2 (PAPP 1957).

Culm: 144.3 cm on the average (range: 114.5—158.5 cm according to years), thick, elastic, with great standing ability. The developing culm is covered with thick wax-layer; its colour is therefore grayish-green. The weight of the individual culm is 0.15 g on the average.

Foliage: the leaf-blades are broad and turning back; the surface is covered with a wax-layer; their colour is grayish-green; size: medium long.

Ear: of parallel form; the ears are mostly short (9—9.7 cm) and full, however, there are also longer ones (till 20.9 cm) and individuals with looser ears (the stand is not uniform). The average weight of the ear is 1.1 g. The weight of grains in the ear is 0.5—0.9 g, and their number ranges from 20—30(60). It is less inclined to imperfect pollination than other varieties. On the main vein of the awn sturdy (to the most 0.5 mm) thickly and slantwise standing hairs can be observed (MÁNDY 1962).

Caryopsis: they fit well to the ear and, thus, no loss of grain occurs. They are full, elongated and the colour is a grayish-green one of different shades. The range of thousand-grains weight is 25—33 g. The protein content of grains is 10—11 per cent, this being the best among the improved Hungarian varieties.

Biological characters:

Germination: the more concentrated (3 per cent) KNO_3 inhibits it but slightly, however, the similar cc solution of KCl decreases to a greater extent its germinative ability (MÁNDY—PÁL, 1960b). The cardinal points of germination are: minimum + 1 °C, optimum + 20° C, maximum + 37° C; the duration of germination under optimum conditions is 6 days (MÁNDY—PÁL, 1960a).

Vegetation period: from seeding to earing on the average 214 days (ranging from 188 to 235 days), from seeding to ripeness on the average 264 days (ranging from 235 to 286 days) (PAPP 1957, MÁNDY—KOVÁCS 1960).

Development: the rate of development is slow, however, the tillering is vigorous and hence, the stand is thick; its ripening is medium-late (KAPÁS *et al.* 1965).

Winter hardiness: is excellent, it also puts up with snowless cold conditions.

Resistance to diseases: it is susceptible to powdery mildew and to brown-rot.

Farm technology requirements:

Sowing: In Hungary it is the most favourable to perform sowing in September 10—20; seed requirement: 2.7—2.8 million embryos per cadastral yoke (1 cad. yoke = 5754.56 m^2 = 1.422 acres), about 80 kg/cad. yoke (BAUER 1966).

Soil: Sandy soil being in good cultural condition, — the best are the chalky sand soils of the Region between the rivers Duna—Tisza; average dosages of fertilizers increase the yield (200 kg/cad. yoke pétisó, 100 kg/cad. yoke of superphosphate and 50 kg/cad. yoke of potassium salt) (BAUER 1966).

Productivity: under suitable circumstances it yields on the average 17 q/cad. yoke of grains (range: 8.8—26.3 q/cad. yoke).

Area of cultivation: it can be successfully grown on the chalky sand-soils of the area between the rivers Duna—Tisza (KAPÁS *et al.* 1965).

GY. MÁNDY

REFERENCES

BAUER, F. (1966): A rozs (The Rye). In: LÁNG *et al.:* A növénytermesztés kézikönyve (A Manual of Plant Growing). Mezőgazdasági Kiadó, Budapest, **1**, 112—31.

KAPÁS, S. *et al.* (1965): Minősített növényfajtáink (Our State Qualified Plant Varieties) Mezőgazdasági Kiadó, Budapest.

MÁNDY, GY. (1962): Alaktani és élettani vizsgálatok hazai nemesítésű rozsfajtákkal (Morphological and Biological Studies with Rye Varieties Improved in this Country). Agrobotanika, **3**, 41—52.

MÁNDY, GY.—KOVÁCS, S. (1964): Adatok a hazai és külföldi rozsfajták ökológiájához (Data on the Ecology of Rye Varieties in this Country and Abroad). Előadás (A lecture). Botanikai Közl., **52/3**, 169.

MÁNDY, GY.—PÁL, GY. (1960a): Adatok hazai nemesített rozsfajták csírázásélettanához (Data on the Germination Biology of Rye Varieties Improved in this Country). Növénytermelés, **9/1**, 47—58.

MÁNDY, GY.—PÁL, GY. (1960b): Sóoldatok hatása a rozs, a zab és a napraforgó csírázására (The Effect of Salt Solutions on the Germination of Rye, Oats and Sunflower). Növénytermelés, **9/4**, 343—358.

PAPP, ZS. (1957): Rozs, *Secale cereale* L. Nemesített Növényfajtákkal Végzett Orsz. Fajtakísérletek Eredményei 1955 (The Rye, *Secale cereale* L. Results of the State Variety Experiments made with Improved Plant Varieties 1955). Mezőgazdasági Kiadó, Budapest, 131—143.

THE OLDEST HERBAL IN HUNGARIAN

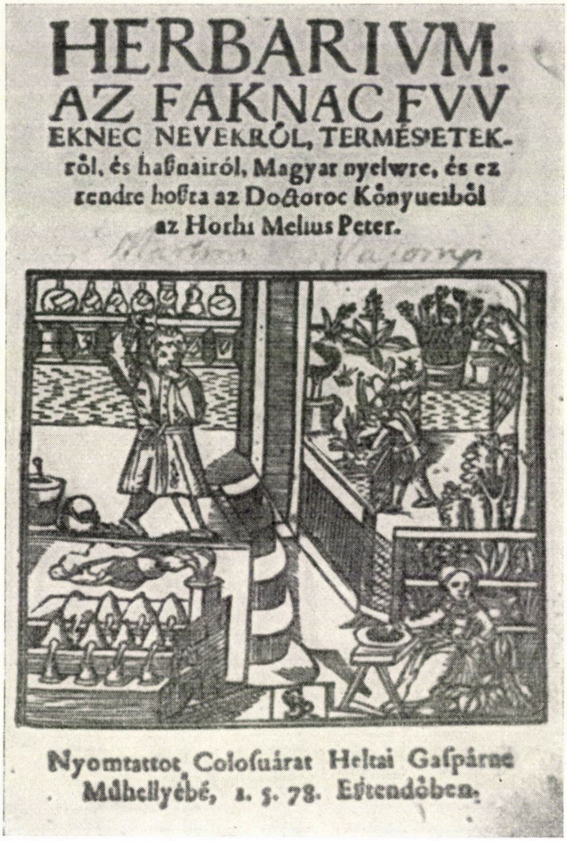
The 16th century in which Peter Melius Juhász's Herbarium was written and published, is one of the most dynamical periods in history. Besides the quick technical development started as early as the previous century, natural sciences are also getting more and more released from the cords of scholasticism. It is mainly the botanical literature that starts to thrive. The Italian, Dutch and German herbals —Kräuterbücher—appearing in the first half of the century, reflect a new and direct aspect of nature. As opposed to the mediaeval Hortus Sanitatis rather rich in fantastic elements, they show a more realistic and practical trend of botanical investigations. First of all plants used in medical science, are searched for and are described. In Hungary this medico-botanical trend is maintained till the end of the 18th century, up to the start of floristical and plant geographical researches.

Who were the first Hungarians to propagate the results of natural sciences obtained in the 16th century? Those studying at foreign universities mainly at universities in Germany and Switzerland who, besides their theological studies, got acquainted also with the natural sciences in the period of the Reformation, and on returning home, they did their utmost to employ profitably their knowledges in the very difficult historical situation prevailing in a Hungary that had been cut into three parts after the Mohács Disaster (1526).

Peter Melius Juhász, one of the most interesting characters of the Hungarian Reformation period, has also brought his knowledge of natural sciences from Wittenberg and his name has been definitely linked together with the first Hungarian Herbal.

The year of his birth has given rise to philological disputes; according to recent investigations the year 1536 seems to be more presumable than the previously accepted 1515. — In 1556 we find him in Wittenberg studying theology together with Gáspár Károli who was the first one to do the complete Hungarian translation of the Bible. Returning home he first became pastor and then bishop of Debrecen exerting indefatigable spiritual activities up to his death in 1572. He has been considered as a leading personality of the Hungarian Calvinism; his literary activities are preserved in 26 theological and polemist works. Still, with respect to the history of science in Hungary the most valuable one seems to be his only secular work: "*Herbarium az Fáknak Füveknek nevekről, természetekről és hasznairól*" (Herbal on the Names, Nature and Use of Trees and Herbs). The book was published after Peter Melius Juhász's death, in Kolozsvár in 1578. The foreword written by Mrs. Gáspár Heltai, widow of the printer in Kolozsvár describes the author's activities as follows:

"He busied himself in gathering medicines for various illnesses and describing them into Hungarian, his writings and the efforts to compile the material from the books of many a wise Doctor, were those of a pious Man". (Quotation from the "Introductory Words" to the Herbal.)



HERBARIVM.
AZ FAKNAC FVV
EKNEC NEVEKRŐL, TERMÉSZETEK-
ről, és haſznairól, Magyar nyelwre, és ez
rendre hoſzta az Doctoroc Kőnyueiből
az Horhi Melius Peter.

Nyomtattot Coloſuárat Heltai Gaſpárné
Műhellyébé, 1. 5. 78. Eſztendőben.

Fig. 1. The front page of P. Melius Juhász's book

From the foreword of Mrs. Heltai the two essential features of the book become evident: the practical end in view and the compiled character of the work. Through that medico-botanical book Melius wanted to give medical advice to the folk of the Plains. This tendency is reflected in his populistic idioms, the simplicity of his style, the avoiding of the expensive medicines, etc. But if we think of that epoch, it seems sure that Melius the protestant preacher being in close contact with the people of his congregation, had to identify himself with the humanitarian aim of curing. Since at that time no Hungarian science had existed yet, and Melius could not rely on precedences in this country, the chief sources were his contemporaries in Europe and some authors of the ancient world, respectively, whose works must have called his attention as early as his stay in Wittenberg. In the Herbarium he mentions the names of Lonicerus, Matthiolus, Tragus, Fuchs, Dioscorides, Plinius and Galenus. He has read their books using their knowledge in his own work in a compilative manner. However, when speaking of the therapeutic use of plants, he does not accept their advice in a servile way, — he quite often enters into controversy with them criticizing especially the superstitious concepts of ancient authors.

"Columella says that the shepherds cure the pest of the sheep with the cute Christmas rose *(Helleborus niger)*, however, Columella as well as Plinius do things, like old witches, by magic." (Melius Herb. p. 187.)

When finding the appropriate name of plants and in describing same, he mainly goes after the work of Adam Lonicerus: Historiae naturalis opus novum (1559 or 69?), and thus connecting erroneously plant species that do not belong together. At the beginning he only summarizes the text of Lonicerus (about 52 articles) while the following 70 ones are identical with Lonicerus, original text of these being literally translated; the subsequent 111 articles are of considerably larger size. In these he has availed himself of other sources, too: the works of the above-mentioned authors. Especially when speaking of the "internal and external" use of plants, he furnishes more data than Lonicerus. From the various sizes of the articles those studying the Herbal, might draw the conclusion that Melius' work hasn't been written continuously but in four parts (cf. E. Gombocz: The History of Hungarian Botany).

Let us see briefly the construction of the work! First of all, the wood-print of the cover-page deserves our attention. Though Pál Gulyás has proved (cf. Magyar Könyvszemle;Hungarian Book Review, XXXVI. 1—8) that the cover-page is but a combined copy of the wood-prints to be found in the above-quoted book of Lonicerus and its technique is not perfect, however, ranking after the famous Corvinus manuscripts, it belongs to the first modern products of Hungarian book-illustrating.

At the beginning of the book we find an Index containing the trees and herbs discussed in alphabetical order, in Latin, Hungarian and German languages. (It is to note that in those days the knowledge of the Latin was more natural than that of the German in this country.) That is followed by another list of names of various illnesses. Author discusses the plants used for medical purposes, in 233 articles; first he deals with trees and then with medicinal herbs. It is interesting to study the wealth of names in one single example!

De Menta

Menta	Domestic Mint	Münz
Menta rubea	Crimson Mint	Rott müntz
Menta crispa	Crisp Mint	Krauss müntz

"The Domestic Mint" is called, in Greek, Hedyosmus viz., "Of Delightful Smell"; one is called "Our Lady's Mint"; the other is the Crisp Mint: The third one is the Crimson Mint, the Black — and Bergamot Mint. The Crisp Mint is better than all the others. Ancient people had called the Garden, - Domestic- and Field Mint Calaminta; the Field Mint is the Pleasant Smelling Mint: Mint is considered Brain Stimulating Domestic Mint. The properties are not much better than those of the Field- and Domestic Mint". (Melius Herb. p. 104). On the basis of E. Gombocz's identification, here we have to deal with the *Crysanthemum balsamita*, the *Mentha Crispa* and the *Mentha Gentilis*. As it might be observed, Melius gives considerably more Hungarian names. These are partly the correct equivalents of the Latin and Greek words (e.g. "Crimson Mint, Crisp Mint", "Mint of Delightful Smell"), and partly he submits the Hungarian variants collected by himself (e.g. "Our Lady's Mint", "Black- and Bergamot Mint", "Field — and Fragrant Mint" and the "Brain Stimulating Mint". The entry-words and the names are followed by the information on the "Nature, the Internal and External Uses" of the plant in question. (These are Melius'original subcaptions.) No coherent system and morphological description are met with in the book. Speaking about the nature of the plants, Melius generally submits the characteristics of the plants according to the old humoral system: those of moistening, drying, warming or cooling (cf. Natter-Nád M., Communicationes BHMH. XXIII. 335—359). Melius enumerates 627 plant species of which the identification could be made by E. Gombocz in the case of 394 species. (cf. E. Gombocz: A magyar botanika története. — The History of Hungarian Botany). The medico-botanical evaluation of the Herbal is the merit of J. Halmai. After all the question might arise that, in spite of the compiling character of the Herbarium, in what Melius proved to produce a pioneer work?

1. He had a book, containing the therapeutical results of the century, brought within easy reach of a larger number of people in Hungarian language in an age the prevailing language of which used to be the Latin (same was the situation in the following centuries, too).

2. For the Latin, German and Greek names he had to give Hungarian equivalents — being assisted by very few literary precedents only (before Melius it had been but the Hungarian translation of J. Murmellius's glossary containing names of plants. Melius could not have read the glossary of Balázs Szikszai Fabricius that was published in 1590). The mere fact that in his work Melius enumerates and describes, respectively, the 627 plant species giving about 2000 Hungarian plant-names, shows that author has used not only the parallel equivalents; it seems that as he was travelling a lot in this country, he deliberately observed and collected the plant names.

3. The enumeration of provenances in several chapters of the Herbal is also the result of independent research work. On the *Prunella vulgaris* e.g., Melius writes as follows: "Much of it is to be found on the meadows of the Nyírség, in the fields of Percz and Bodoház the abundant flowers are purple-blue, their size is the length of a span and never more" (Melius Herb. p. 88).

The "Nyírség" is a geographical unit in Hungary. That example also illustrates that, contrary to the contemporary "Kräuterbücher", Peter Melius Juhász submits in his book also positive data on the provenance of many a plant which is already a trait towards floristics and plant geography; this is in which lies the main novelty of the book. Summarizing: Peter Melius Juhász's Herbal is recorded as the first document of the Hungarian botanical and medical literature. It is a rich source of several research problems, e.g.: it is valuable concerning our relation to European literature on botany as well as in revealing Hungarian plant names, names of illnesses, healing methods all to which it submits the first positive data. It is with much appreciation that we find its modern publication among the volumes of the Communicationes ex Bibliotheca Historiae Medicae Hungarica, appeared, after the correction of the technical and orthographical errors in the original print, under the auspices of Gábor Incze.

M. Csernák

REFERENCES

Melius Juhász, P. (1578): Herbarium az Fáknak Füveknek nevekről, természetekről és hasznairól (Herbal on the Names, Nature and Use of Trees and Herbs), Kolozsvár, Heltai Gáspárné műhelye (printing works of Mrs. Gáspár Heltai).

Horhi Melius, P. (1962): Herbarium (Communicationes ex Bibliotheca Historiae Medicae Hungarica. XXIII.) Kiadta Incze Gábor (Publication of Gábor Incze).

Gombocz, E. (1936): A magyar botanika története (The History of Hungarian Botany). Budapest.

Gombocz, E. (1939): A hazai természettudósok rövid életrajza (Brief Biographies of Natural Scientists in this Country). Budapest.

Bán, I. (1962): Melius Juhász Péter (Communicationes BHMH XXIII. 252—280).

Halmai, J. (1962): Adatok a Herbarium orvos-botanikai értékeléséhez (Data on the Therapeutical-botanical Evaluation of Herbal), (Communicationes BMHM. XXIII. 281—334.).

Natter-Nád, M. (1962): A Herbarium növényei (The Plants of the Herbal), (Communicationes BHMH. 335—359).

B. Eötvös, L. (1884): Ismertetés Dr. Fialovszky Lajos "Melius Péter Herbariumáról" c. értekezéséről (Review on the Treatise of Dr. Fialovszky Lajos under the title: On the Herbarium of Melius Péter) Mathematikai és Természettudományi Értesítő, *III*, 19—22.

HORVÁTH, J. (1953): A reformáció jegyében (In the Spirit of Reformation). Budapest
GULYÁS, P. (1929): Melius Péter Herbariumának címképéről (On the Cover Frontispiece of Peter Melius' Herbarium). Magyar Könyvszemle, XXXVI, 1—8.

CHANGE OF TOTAL CHLOROPHYLL IN VEGETABLE PLANTS

In our experiments the quantitative formation of pigments has been investigated in the function of plant development as well as under the influence of being covered with orange-coloured foils. The quantity of the pigments is in correlation with the productivity of photosynthesis. Linear correlation shows itself between the chlorophyll content referred to the unit of the leaf-blade and the intensity of photosynthesis. With a chlorophyll content falling to a leaf-surface of 0.02 mg/cm^2, the productivity of the photosynthesis decreases to 0 (SESTÁK—CATSKY 1962, SESTÁK 1966).

The quantitative formation of the pigments is influenced by the intensity of lighting (FRIEND 1960, HORVÁTH 1966) and the length of illumination. The chlorophyll content is different in the various phases of ontogenesis being the highest during flowering. With one-year plants and with perennials seasonal chlorophyll changes can be observed (GERHOLD 1959). A change of the chlorophyll content according to the parts of the day, has also been observed. According to the investigations of BUZOVER (1959) the pigment content is the highest in the noon-hours while it is the lowest at night. The quantitative formation of the pigments is also influenced by the spectral composition of light as has been proved by investigations increasing in number since the fifties. BRANDT (1958) and KAHNOVICS (1960—61) have raised plants in light of various wave-lengths under conditioned circumstances, however, under physiologically identical active light intensity. They have established that when stressing the red and the blue wave ranges, the quantity of chlorophyll-*a* and chlorophyll-*b* has increased. ALPATOVA (1962) has stated that in the case of photophilous plants the red and yellow colour ranges are favourable for the pigment synthesis while with plants liking shadow, the blue and violet ranges are favourable for this purpose.

According to HORVÁTH's (1966) investigations, the spectral composition of light has an influence primarily on the quantitative changes of the two green components. Within the range of the green components the ratio of chlorophyll-*a* and chlorophyll-*b* changes considerably. With cereals, in the function of time the proportion of chlorophyll-*a* is 47—64 per cent. The proportion of chlorophyll-*b* is 19.6—39.3 per cent. The effects of natural light and that of foils having different colours, display themselves most with the quantitative values of chlorophyll-*a*. The quantity of the yellow components also changes, however, that change is in proportion with the joint quantitative change of chlorophylls *a* and *b*. Consequently, the ratio of the green and yellow pigments in various plants and at different time, might be considered nearly identical = 6 : 1.

As experimental plants the elongated vegetable marrow, bloomy cucumber from Kecskemét and the "Ditmar" variety of cabbage have been used. The vegetable marrow and the cucumber have been raised under green-house conditions in sand culture. They have been treated with 0.01 per cent Knopp-solution. The total chlorophyll content was examined in 19—28-day-old plants. As to cabbage, the chlorophyll content has been determined in plants raised in natural light. Samples were taken from field production every two weeks from plants of 1—3 months, while under green-house conditions the samples were taken weekly from plants of 1—1.5 month. Finally, in all three plants the effect of orange-red foils was examined after having them covered up for 3—8 days. The experiments were performed in five repetitions. The determination of chlorophyll was carried out according to FADEL (1962), as well as OZEROL—TITUS (1965); measurings were carried out on the photometer of type Spektromom 201.

In our experiments the change of the total chlorophyll content has been examined in vegetable marrow and cucumber plants being 19—28 days old while concerning cabbage, this has been done with plants being of 15—81 days. Our results are shown in Figs. 1 and 2.

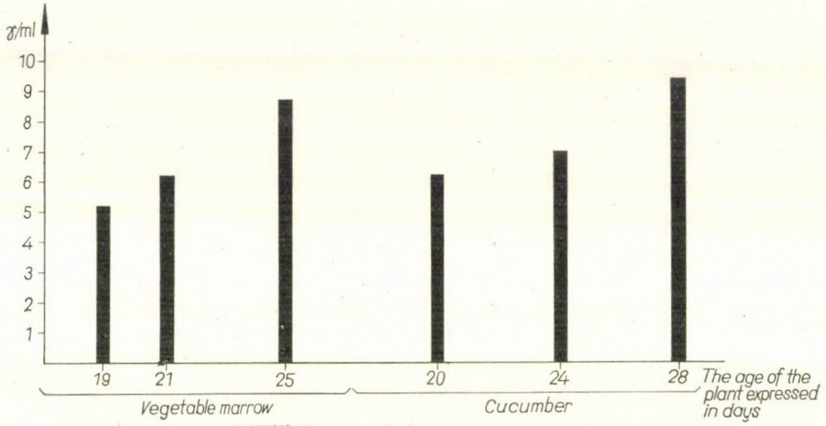


Fig. 1. Change in the total chlorophyll content of vegetable marrow and cucumber in the course of development

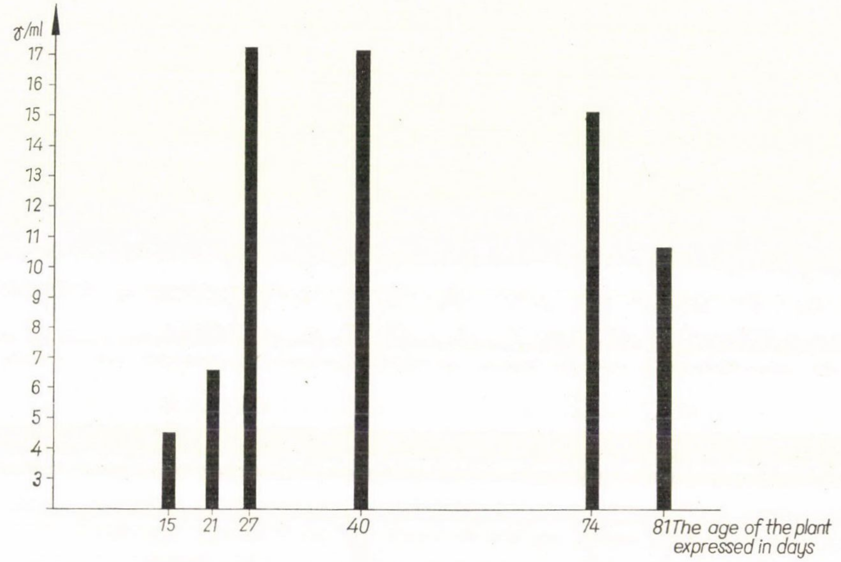


Fig. 2. Change in the total chlorophyll content of cabbage during growth

From the Figures it can be seen that in the case of vegetable marrow and cucumber the total chlorophyll content increased during the period of the investigations.

As to cabbage, the quantity of total chlorophyll increased up to the age of 3—4 weeks, while from the 5th week on it began to decrease. The increase in the quantity of total chlorophyll is explained by the fact that as long as the growth through division lasts, the accumula-

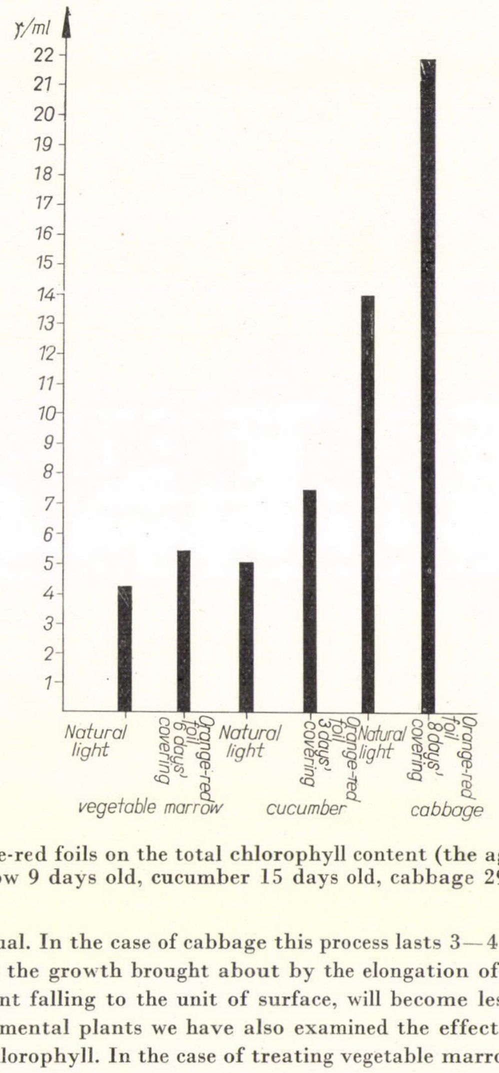


Fig. 3. Effect of orange-red foils on the total chlorophyll content (the age of the plants: vegetable marrow 9 days old, cucumber 15 days old, cabbage 29 days old)

tion of pigment is gradual. In the case of cabbage this process lasts 3—4 weeks; after this there comes into prominence the growth brought about by the elongation of the cell therefore, the total chlorophyll content falling to the unit of surface, will become less.

With our experimental plants we have also examined the effect of orange-red foils on the quantity of total chlorophyll. In the case of treating vegetable marrow, we have placed the foil on 6-day-old plants, with cucumber this happened when the plants were of 9 days while in the case of cabbage, the plants were 21 days old when covered with the foil. The time of covering — in the above sequence — was 3.6 and 8 days. Our results are shown in Fig. 3.

The data of the experiments show that the orange-red foil had positive effect on the quantity of total chlorophyll. Expressed in figures, the increase of chlorophyll content as compared to the control being raised in natural light, will be 30.00 per cent in the case of vegetable marrow, 48.00 per cent with cucumber and 51.10 per cent with cabbage.

*

Prepared by the Department of Plant Physiology, Lóránd Eötvös University, Budapest.

J. Bálint, L. Kerecsényi, D. Sárkány, M. Horváth

REFERENCES

ALPATOVA, E. F. — Алпатова, Е. Ф. (1962 a): Влияние отдельных лучей спектра на образование пигментов в этиололированных проростках. Сб тр. по агрон. **9**, 70—74.

ALPATOVA, E. F. — Алпатова, Е. Ф. (1962 б): Влияние спектрального состава и мощностей лучистых потоков на ростовые процессы проростков сельскохозяйственных растений. Тр. кирг. АН. Инст. земл. **4**, 203—212.

BRANDT, A. V. — Брандт, А. В. (1958): Синтез и накопление каротиноидов при действии света различного спектрального состава и интенсивности. Биофизика, **3**, 698—702.

BUZOVER, F. JA. — Бузовер, Ф. Я. (1959): Количество хлорофилла и дневной ход фотосинтеза у картофеля. Тр. харьк. с/х инст. **19**, 2—12.

FADEL, A. A. (1962): Localisation and Properties of Chloroplasts and Pigment Determination in Roots. Physiol. Plantarum, **15**, 130—147.

FRIEND, D. J. C. (1960): The control of Chlorophyll Accumulation in Leaves of Marquis Wheat by Temperature and Light Intensity. I. The Rate of Chlorophyll Accumulation and Maximum Absolute Chlorophyll Content. Physiol. Plant., **13**, 776—785.

GERHOLD, H. D. (1959): Seasonal Variation of Chloroplast Pigments and Nutrient Elements in the Needles of Geographic Races of Scotch Pine. Silvae Genet., **8**, 113—123.

HORVÁTH, I.—VAJDAI, I. (1963): Különböző színképi összetételű fényben nevelt növények fotoszintetikus pigmentkomplexének fényabszorpciója (Light-absorption in the Photosynthetic Pigmentcomplex of Plants Raised in Light with Various Spectrum-compositions). Az Agrártudományi Egyetem Mezőgazdaságtudományi Karának Közleményei, 395—404.

HORVÁTH, I. (1966): A fény színképi összetételének hatása a szervesanyag produkcióra (The Effect of the Spectral Composition of Light on the Production of Organic Material). Doktori disszertáció (Doctoral Dissertation).

KAHNOVICS, L. V. — Кахнович, Л. В. (1960): О накоплении хлорофилла *а* и *б* и изменении размеров и количества хлоропластов в листьях репы в зависимости от разного качества света. Докл. АН СССР. **4**, 263—264.

KAHNOVICS, L. V. — Кахнович, Л. В. (1961): Накопление пигментов и изменение размеров и количества хлоропластов в листьях салата в зависимости от иненсивности освещения различными типами люминесцентных ламп. Сб. вопр. физиол. раст. и микробиол, **2**, 78—85.

OZEROL, N. H.—TITUS, J. S. (1965): The Determination of Total Chlorophyll in Methanol Extracts. Trans, III. State Acad. Sci., **58**, 150—151.

SESTÁK, Z. (1966): Construction of a Simple Nomogram for Evaluating Two-Wavelength Spectrophotometric Determination of Chlorophylls. Biol. Plantarum (Praha), **8**, 97—102.

SESTÁK, Z.—CATSKY, J. (1962): Intensity of Photosynthesis and Chlorophyll Content as Related to Leaf Age in *Nicotiana sanderea* Hort. Biol. Plant., **4**, 131—140.

TWO NEW HOST PLANTS FOR POTATO VIRUS Y, POTATO VIRUS X AND POTATO AUCUBA MOSAIC VIRUS

The host range of potato virus Y (PVY), potato virus X (PVX) and potato aucuba mosaic virus (PAMV) is known to be very wide (reviewed by LADEBURG *et al.* 1950, KOLLMER — LARSON 1960, THORNBERRY 1966, SCHMELZER 1967, HORVÁTH 1968). Plant species belonging to the family *Solanaceae* are especially susceptible to the above potato viruses. Of the genus *Browallia* which belongs to the family *Solanaceae* the following species were studied with respect to their applicability as test plants: *Browallia elata* L., *Browallia speciosa* Hook., *Browallia zervaskiana**. *Browallia elata* L. proved to be susceptible to PVX and resistant to both potato virus A (PVA) and PVY (STELZNER—SCHWALB 1943). BAGNALL *et al.* (1956) found it to be susceptible to potato virus M (PVM) and potato paracrinkle virus (PPV). *Browallia speciosa* Hook. is susceptible to PVX (DENNIS 1939), cucumber mosaic virus [CMV (PRICE 1940)] and tomato spotted wilt virus [TSWV (SMITH 1957)]. According to STELZNER—SCHWALB

* Author unknown

(1943) *Browallia viscosa* H. B. K. is susceptible to PVY and resistant to PVX as well as PVA. In experiments carried out so far (cf. Stelzner—Schwalb 1943) *Browallia zervaskiana* exhibited resistance to PVY, PVX and PVA. Of the genus Nicotiana (also *Solanaceae)* Stelzner—Schwalb (1943) tested the behaviour of *Nicotiana texana* L. They found that this species was resistant to PVY and PVA and slightly susceptible to PVX.

The aim of the present study was to test whether or not *Browallia demissa* L., a *Browallia* species not studied so far in this respect, could be used for the detection of potato viruses and to reinvestigate the reaction of *Nicotiana texana* L. to PVY and PAMV.

For the experiments four strains (cf. Horváth 1966a, b, 1967a, b) of PVY, isolate X^G (Horváth—Beczner 1968) of PVX and an isolate (Hollings 1959, 1966) of PAMV were used.

In the mechanical inoculations, raw sap extracted with a mortar and pestle from young recently infected plants of *Nicotiana tabacum* L. cv. *Samsun* (with PVY and PVX) and of *Nicotiana glutinosa* L. (with PAMV) was applied with a glass spatula to the leaf surfaces of young plants of *Browallia demissa* L. and *Nicotiana texana* L. White carborundum (500 mesh) was used as an abrasive. The leaves were rinsed with a fine spray of water after inoculation.

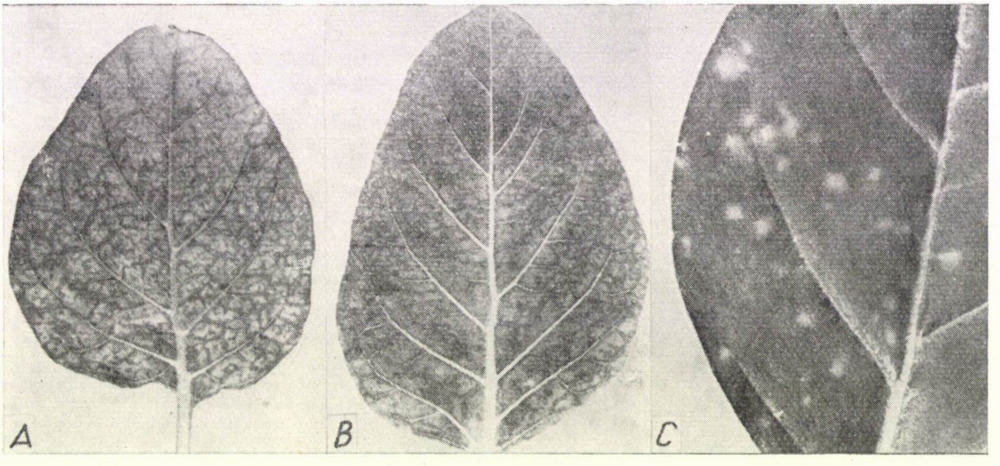


Fig. 1. Nicotiana texana L. plants infected with potato virus X (A), potato virus Y (B) and potato aucuba mosaic virus (C)

It was found that *Nicotiana texana* L. reacted with systemic symptoms to all three viruses tested. Upon infection with PVX the mosaic symptoms became especially severe (Fig. 1A). PVY caused somewhat milder symptoms (Fig. 1B). PAMV induced the formation of circular chlorotic spots (Fig. 1C), some inoculated individuals, however, proved to be symptomless carriers. From these plants the virus could always be recovered.

Our experimental results confirm the data of Stelzner—Schwalb (1943) with respect to PVX on the one hand, and show *Nicotiana texana* L. to be a host plant of PVY and PAMV, on the other. The diagnostic value of *Nicotiana texana* L. is increased by the finding that in artificial infection tests it proved to be less susceptible to *Peronospora tabacina* Adam (PtA) than several other *Nicotiana* species extensively used in plant virus work (Tuboly 1967).

In the experiments *Browallia demissa* L. showed severe systemic vein clearing and mosaic pattern when infected with either PVY or PVX (Figs. 2A and B). No local symptoms were

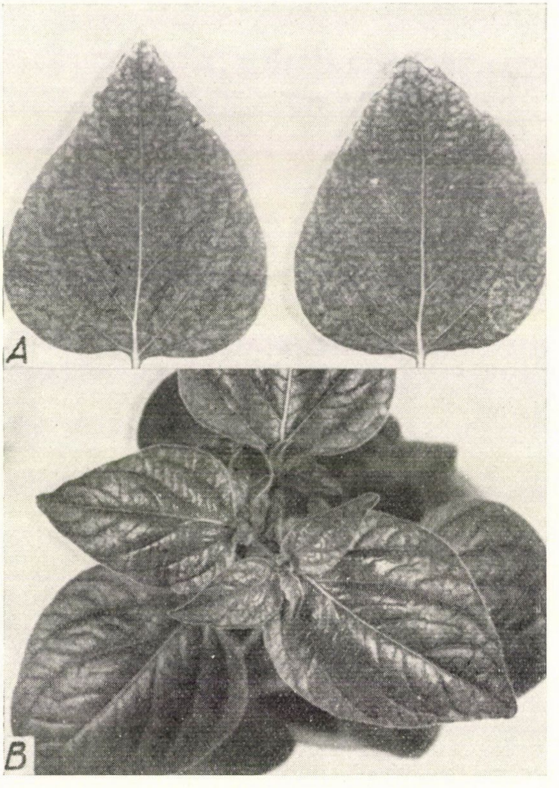


Fig. 2. Symptoms caused by potato virus X (A) and potato virus Y (B) on *Browallia demissa* L.

produced. Both PVX and PVY could be recovered from inoculated *Browallia demissa* L. plants. The number of lesions produced on local lesion hosts *(Gomphrena globosa* L., *Solanum demissum* hybride A6) by inocula taken from inoculated *Browallia demissa* L. plants indicated that both PVX and PVY reached a high concentration in the above systemic host. *Browallia demissa* L. was resistant to PAMV.

Acknowledgements

Thanks are due to Dr. M. HOLLINGS (Glasshouse Crops Research Institute, Littlehampton, Sussex, England) for providing me with their strain of potato aucuba mosaic virus and Miss É. TARCSI, Miss É. BALOGH for their valuable technical assistance as wells as to Mrs. O. KASSAI for preparing the photographs.

*

Prepared by the Department of Plant Pathology, Research Institute for Plant Protection, Budapest.

J. HORVÁTH

REFERENCES

DENNIS, R. W. G. (1939): A new test plant for potato virus X. Nature, **142,** 154.
HOLLINGS, M. (1959): Host range studies with fifty-two plant viruses. Ann. Appl. Biol. **47,** 98–108.
HOLLINGS, M. (1966): Personal communication.
HOLMES, F. O. (1946): A comparison of the experimental host range of tobacco-etch and tobacco mosaic viruses. Phytopathology, **36,** 643–659.
HORVÁTH, J. (1966a): Studies on strains of potato virus Y. 1. Strain C. Acta Phytopath. Acad. Sci. Hung., **1,** 125–138.
HORVÁTH, J. (1966b): Studies on strains of potato virus Y. 2. Normal strain. Acta Phytopath. Acad. Sci. Hung., **1,** 333–352.
HORVÁTH, J. (1967a): Studies on strains of potato virus Y. 3. Strain causing browning of midribs in tobacco. Acta Phytopath. Acad. Sci. Hung., **2,** 95–108.
HORVÁTH, J. (1967b): Studies on strains of potato virus Y. 4. Anomalous strain. Acta Phytopath. Acad. Sci. Hung., **2,** 195–210.
HORVÁTH, J. (1968): Studies on the host range of potato virus Y. Proc. 6th Conf. Czechoslovak Plant Virologists, Olomouc, 1967.
HORVÁTH, J.—BECZNER, L. (1968): A diagnosztikai víruskutatás újabb eredményei. 1. Burgonya Y-, X-, aukubamozaik- és dohánymozaik vírus (Recent results of diagnostical virus research. 1. Potato virus Y-, X-, aucuba mosaic- and tobacco mosaic virus). XVIII. Conf. Plant Protection, Budapest, 1968.
KOLLMER, G. F.—LARSON, R. H. (1960): Potato virus F in relation to host range, properties, reaction of American potato varieties, and resistance. Univ. Wisc. Res. Bull., **223,** 1–40.
LADEBURG, R. C.—LARSON, R. H.—WALKER, J. C. (1950): Origin, interrelation and properties of ringspot strains of virus X in American potato varieties. Univ. Wisc. Res. Bull., **165,** 1–47.
PRICE, W. C. (1940): Comparative host ranges of six plant viruses. Amer. J. Bot., **27,** 530–541.
SCHMELZER, K. (1967): Wirte des Kartoffel-Y- und des Tabakätzmosaik-Virus ausserhalb der Solanaceen. Phytopath. Z., **60,** 301–315.
SMITH, K. M. (1957): A textbook of plant virus diseases. London 1957.
STELZNER, G.—SCHWALB, H. (1943): Reaktion einer Reihe von Solanaceen auf Infektion mit A-, Y- und X-Virus der Kartoffel unter Berücksichtigung ihrer Brauchbarkeit als Testpflanze. Phytopath. Z., **5,** 497–511.
THORNBERRY, H. H. (1966): Index of plant virus diseases. Agr. Res. Serv. U. S. Dept. Agr. Agriculture Handbook **357,** 1–446.
TUBOLY, L. (1957): Personal communication.

HUMPHRY DAVY AND FERENC PETHE

If considering the foreign influences exerted on the development of Hungarian agriculture, England's first place and rank cannot be disputed. As early as at the end of the 18th century the results obtained by Robert Bakewell in breeding beef-cattle and brood stock as well as those of Young gained in fodder production and through the four-course rotation system, became fabulous, indeed. Unfortunately, these cases could not have significant effect on the backward system of rearing cattle in the open-air all the year round, — as it was common in this country. These precedents only served as stimulating factors for the farm managers or agricultural engineers employed at the more important estates. It was also the effect of inspiration or rather that of amazement produced by English agrochemistry aiming at the improvement of soil; with Davy's appearance this caused positive admiration all over Europe.

At the beginning of the 19th century Davy had a book published on the results of his agrarian-chemical experiments. His theory as well as his practical instructions were meant to encourage more and better yields. Unfortunately, the new branch of science was such novelty in Hungary that it was not even understood and, consequently, people did not find it worth while improving the soil in artificial ways. Those who believed in chemistry or those dealing with it, were considered eccentric scientists or even sorcerers.

Fig. 1. The portrait of Ferenc Pethe of Kisszántó

In this country it was Ferenc Pethe of Kisszántó who translated Davy's book "Elements of Agricultural Chemistry" (1814); he had it published in Vienna in 1815. Pethe, too, was a scientist not taken seriously by his contemporaries. A lecturer at the Keszthely Georgicon Agricultural High School, he had then been publishing for nearly two decades the agrarian culture of the most developed western countries. No wonder that the agriculturist — being a natural scientist — read Davy's agrochemistry with keen interest. In it he saw a key for securing the higher yield of future agriculture. And to make the best use of what he read, he would have liked to introduce it as soon as possible.

But let us see more closely the direct connection of the agrarian scientist who, in this country, was a "man making an early appearance in science", with Davy's agrochemistry and the Hungarian circumstances as well.

The name of Sir Humphry Davy, one of the most prominent personalities of the industrial revolution, had already been known in Hungary — though in a close circle — after his records on potassium, sodium, barium, magnesium, etc. His electrotheory had reached us as well. The chemist-inventor of real genius produced the most of his knowledge in his "Agrarian Chemistry" as referred to by Pethe in his foreword entitled: "The translator's address: .. It is for long time that such work has been given, especially to us Hungarians, by a nation that is mostly and almost generally, expected to produce but concentrated works . ."

In its first form the "concentrated work" appeared as a supplement to the paper called "The National Farmer" edited and published by Ferenc Pethe and then, in 1815 and also in Vienna, it appeared in the form of a book on 440 pages provided with ample of notes by the translator.

The book on chemistry recommended by Pethe as the "good book", consisted of 8 lectures (i.e. chapters). Its items were the following: On the Arrangement of the Soil and on its Use, — On the Kinds of Stones, — On the Sorts of Manure Being of Plant or of Animal

Origin, — On Fermentation and Decomposition, — Salt, Lye, Acids as Useful Elements, — i.e. on all things that are in connection with chemistry.

Though every reader of the Davy-book was dealing with agriculture professionally, that time the book had exerted on the reader the effect of curio only. The most easily understandable topic in the book was manuring, — its realization in practice, however, met great difficulties. In the world of rearing cattle in the open-air all the year round, — in order to realize the gathering, ripening, spreading and ploughing in of the manure in the proper way, stabling ought to have been introduced primarily. Secondly, fuel ought to have been provided in such quantity that people should have been able to do without the dry manure used as combustible. On the Plains and, in general, in unwooded and flat regions this was an insoluble claim. Thus, the general use of agrochemistry had first of all physical obstacles and secondly, it was hindered by ideal motives. In the atmosphere of the surviving Middle Ages spirit other publications on the predominance of Nature were not of great popularity either. The excellent botany book of Diószegi—Farkas was in eclipse for quite a long time. The same happened to Kováts' "Chemistry" and to F. Pethe's "Mathesis". The church declared every natural scientific literary work atheistic. The world-wide known Prof. István Hatvani who, after having made his studies at foreign universities, had performed physical and chemical experiments at the Debrecen college, was named a sorcerer. Ferenc Pethe had been Hatvani's pupil; his "sorcerer" activities, however, culminated in constructing a device for examining calcium content.

To make Hungarian agricultural efforts thrive at the beginning of the 19th century with the aid of chemistry seemed to be impossible under the given circumstances. First the seed had to be sown and that was followed by Davy not only with the aid of chemical formulae, analyses and statistical reports addressed to experts but also by wording his concept understandably for everybody: Cheap and efficient assistance can be expected from scientists only. His Hungarian translator, too, stressed the above: The idea of joining chemistry with agriculture should be considered and followed.

However, in order that the thriving of agrochemistry should start, the most important was to break up the chains of feudalism.

The ideas of Pethe were realized in a very useful way indeed at the beginning of the period following the Independence War of 1848. Davy's agrochemistry rendered great assistance to the developing of Hungarian chemical literature from the middle of the 19th century; it became more and more widespread so that the traditonal method of leaving the soil uncultivated (fallow), was succeeded by the introduction of the useful manuring system, too.

Sándor Süle, biographer of Ferenc Pethe, summarizes the importance of the translation of Davy's book in a very impressive way: The Root of Agrarian Chemistry ". . . is but a step in the history of universal chemistry; referring to Hungarian conditions, however, it is a milestone in Hungarian chemical literature, especially in the history of Hungarian agrochemistry".

F. Sz. Gál

PIGMENT CHANGES IN BEAN AND BROAD-BEAN

In the course of our experiments the pigment changes, as affected by external circumstances, have been examined in the plants.

Among the factors affecting pigment content, light is of the greatest importance. Light intensity and the length of illumination have different roles (Friend 1960). With barley the optimum light intensity is 11,000 lux. (Milier—Zalik 1965). The pigment content changes also in the course of the ontogenetic cycle; the highest values are obtained at the beginning of flowering after which it decreases parallel with the decomposition of proteins (Horváth—Lásztity 1966). Wieckowsky (1963) has examined the effect of temperature on chlorophyll synthesis and has established that at lower temperature (+19° C) the leaves grow more intensively than at higher temperature (+29° C). The fluctuation of the chlorophyll content in the different developmental phases of the plant depends, to a great extent, on fertilization with nitrogen (OBLONSKAYA—ZHADKOVA 1963).

Our investigations have been carried out with the 1964 — *Tétényi* variety of *Vicia faba* (broad-bean) and with the "*Fürj*" *bean* of the year 1966. We have determined the quantitative changes of total pigment, the quantity of chlorophyll being bound loosely or in a medium way. The determinations were made according to the method of FADEL (1962), OZEROL—TITUS (1965), SESTAK (1966). The measurings were performed with the photometer Spectromom of the type 201. Data referring to pigment quantities were submitted in γ/ml. The values are the averages of four repetitions.

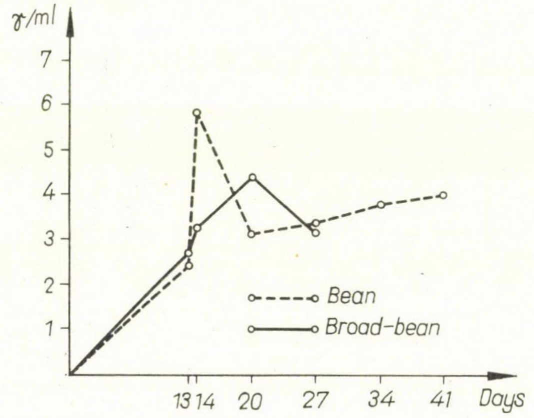


Fig. 1. Quantitative change of total pigment during development

The investigations have been carried out first with plants 13 and 21 days old; then they were raised to an age of 44 days. The results are shown in Fig. 1.

From Fig. 1 it can be seen that the quantity of total pigment in the broad-bean is lower than in the bean. The value of total pigment in broad-bean is lower after 20 days. This shows that by the 20th day the growth of the first 4 leaves had been completed; after this the cell got elongated and thus, the quantity of pigment became distributed on a larger surface. In the case of the bean-plant growth and development, i.e. the process of intensive division respectively were still continuing on the 21st day, — and the quantity of pigment increased. The results obtained were also supported by the succeeding experiments, in which the plants were raised up to 44 days.

In our second series of experiments 21-day old plants were used; the suitable quantity was deprived of the roots, and the isolated parts with leaves and stems were placed in tapwater in a beaker flask together with the control plants having root. An examination was performed two days after having removed the roots. The results obtained are shown in Fig. 2.

The results show that when isolating the leaves together with the stem, the total-pigment quantity decreased as against the control. Parallel with the starting protein hydrolysis the quantity of pigment has also decreased.

In our third experimental series the leaves were removed from the stem and were placed on wet filter-paper in a Petri dish. One part of the isolated leaves was kept in light, while the other in dark. Examinations were performed after 4 days of isolation. In this experiment, too, the age of the plants was 21 days. The results are shown in Fig. 3.

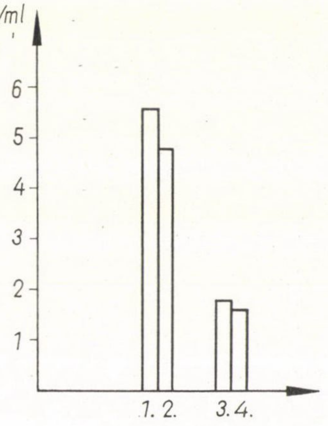


Fig. 2. Change of pigment content in leaves being isolated together. (1. Control bean, 2. Isolated bean, 3. Control broad-bean, 4. Isolated broad-bean)

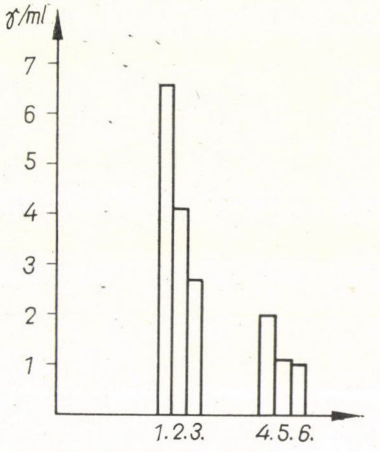


Fig. 3. The change of pigment content in leaves kept in light and dark. (1. Control bean, 2. Bean isolated in light, 3. Bean isolated in dark, 4. Control broad-bean, 5. Control broad-bean isolated in light 6. Control broad-bean isolated in dark)

It can be seen that the pigment-quantity of the isolated leaves has decreased as against the control having root. With both plants the rate of decrease is higher after isolating in dark.

Summarizing our experiments made with the grown varieties of *Vicia faba* and *Phaseolus vulgaris*, the following can be established. The change of pigment in the broad-bean and the two bean varieties shows identical tendency. Isolation has always brought about a decrease in pigment content and a greater decrease in dark than in light. The quantity of total pigment content increases as long as growth, — in case the leaves of plants have stopped growing by division, there exists only growth by elongation, thus the pigment quantity due to a given surface-unit, will decrease.

*

Prepared by the Eötvös Loránd University, Plant Biology Department, Budapest.

K. Dauda, M. Horváth, H. Vincze

REFERENCES

Fadel, A. A. (1962): Localisation and Properties of Chloroplasts and Pigment Determination in Roots. Physiol. Plantarum, **15,** 130—147.

Friend, D. J. C. (1960): The Control of Chlorophyll Accumulation in Leaves of Marquis Wheat by Temperature and Light Intensity. I. The Rate of Chlorophyll Accumulation and Maximum Absolute Chlorophyll Content. Physiol. Plant., **13(4),** 776—785.

Gauntan, O. P. (1962): Appropriate Basis of Expression of Chlorphyll Content. Current Sci., **31,** 30—31.

Horváth, M.—Lasztity, D. (1966): Pigment Changes in Etiolated Barley Leaves. Acta Agronomica, **15,** 119—125.

Milier, R. A.—Zalik, S. (1966): Effect of Light Quality, Light Intensity and Temperature on Pigment Accumulation in Barley Seedlings. Plant Physiol. Kutzteum, 569—574.

Oblonskaya, L. J.—Zhadkova, N. D. — Облонская Л. Я. — Жадкова Н. Д. (1963): Динамика хлорофилла и интенсивность его образования в растениях при различных условиях азотного питания. Изв. АН СССР сер. биол. **28/1,** 108—114.

Ozerol, Nail H.—John S. Titus (1965): The Determination of Total Chlorophyll in Methanol Extracts. Trans. Ill. State Acad. Sci., **58(2),** 150—151.

Šesták, Z. (1966): Construction of a Simple Nomogram for Evaluating Two-wavelength Spectrophotometric Determination of Chlorophylls. Biol. Plantarum (Praha), **8/2**, 97—102.
Wieckowsky, S. (1963): The Influence of Temperature and Light Intensity on the Leaf Growth and Chlorophyll Synthesis. Acta Soc. Bot. Polon., **32/4**, 719—730.

BUDA DWARF BEAN FOR THE CANNING INDUSTRY

(Budai konzerv bokorbab)

Systematical place: *Phaseolus vulgaris* L. ssp. *vulgaris* var. *nanus* Aschers. (Mansfeld 1962).

Origin: Hélia × Aranyeső

Beginning of breeding: 1952, Budapest-Budatétény.

Breeder: Csatári-Szüts Kálmán and Ágnes Baranyai, Horticultural Research Institute, Budapest.

State qualification: Preliminary certified improved variety, 1961 (Kapás *et al.* 1965).

General characterization: Early maturing yellow-pod dwarf bean having a reliably high yield, the pods are free of fibre and are of excellent marketing value.

Morphological description:

Root system: Its spindle-root penetrates into the soil as deep as 80 cm and has rich branches.

Shoot system: Low, sturdy, the shoots standing up stiffly (Gabriel 1963).

Culm: light-green, the internods are short, being covered with hairs in a medium way; the nods around the basis of the leaf are yellowish.

Foliage: the leaves are placed densely; the leaflets are broad-ellyptical, dark green and covered with hairs but thinly; they are of medium size, the apex being acuminate.

Flowers: the corolla is white; the size of the flower is medium.

Fruit: when ripe for marketing, the pod is 14—20 cm long, 15 mm broad, straight, full, the cross-section is round; it is waxen-yellow free from integument and fibre

("fibre-free"). The average weight of the pod is 3.6 g. (range: 3.1—4.1 g), and its value regarding canning properties, is the best among the Hungarian varieties (94.5 points) (GÁBRIEL 1963).

Seed: small, elongated oviform, white.

Biological characters:

Germination: at a soil temperature around 10—15° C it germinates quickly and emerges on about the 14—15th day.

Vegetation period: from sowing to flowering 34—35 days (GÁBRIEL 1963).

Water requirement: it does not require much water.

Resistance to diseases: it generally resists to diseases and is virus resistant (KAPÁS *et al.* 1965).

Farm technology requirements:

Sowing: in the early days of May, the spacing being 40×5—6 cm. Regarding *soil*, it is unpretentious and yet it requires a soil with good management of water supplies.

Productivity: it is the second high-yielding, yellow-pod variety having a yield above the average even when the weather is rather dry. Its yield is significantly higher and of better quality than the variety BrittleWax. It is an early maturing variety, the average yield is 60 q/ha (range: 36—83 q/ha). On the occasion of first picking it yields about 35 per cent of pods being ripe for marketing, while this is 50 per cent at the second picking. Of this at least 88 per cent corresponds with the standards. The colour and taste of the pods are most excellent for canning industry (GÁBRIEL 1963).

Region of cultivation: it can be grown successfully all over the country on soils with good water supply.

GY. MÁNDY

REFERENCES

GÁBRIEL, A. (1963) Bokorbab. Nemesített Növényfajtákkal Végzett Orsz. Fajtakísérletek Eredményei (The Dwarf Bean. Results of State Variety Experiments Carried out with Improved Varieties) 1962., 297—312. Mezőgazdasági Kiadó, Budapest.

KAPÁS, S. *et al.* (1965): Minősített növényfajtáink (Our State Qualified Plant Varieties). 92. Mezőgazdasági Kiadó, Budapest.

MANSFELD, R. (1962): Vorläufiges Verzeichnis landwirtsch. o. gärtnerisch kultiv. Pflanzenarten. Akademie Verlag. Berlin.

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 451—455 (1968)

CHRONICA

TIVADAR HUZELLA

1887—1951

It is sixteen years since the death of Dr. Tivadar Huzella whose colourful character and personality with the passing of time have been ever more clearly fixed in the minds of the present generation. He began his medical career as a pathological anatomist, but what interested him from the outset, was the living structure and its connection with function. It was the shaping influence of function on structure, which predominated his thinking.

In 1921, he was appointed to the Medical Faculty as professor of Anatomy at the newly established Debrecen University and as Director of the Anatomy Institute just starting work in the premises of the one-time South Hungarian Educational Society.* In this provisional place, he accomplished the hard work of laying the foundations of the Institute and organized the Department of Anatomy of the new University of Debrecen in the middle of the Nagyerdő (Great Forest). The difficult work of organizing lasted till 1924, when he could move to the new building of the Department and could place a greater emphasis on his work, in which he set as his aim the shaping of the new university's intellectual life.

He was born of a merchant family at Nagyvárad, from where they moved to Budapest. Naturally his parents would have liked their son to take over their thriving business, but he was more interested in natural science, music and art; he turned towards medical science, where scientific research, the biological bases of medicine, man and the living world's relation stood in the centre of his thinking which was enriched by natural philosophy. His sphere of interest, in this way, outgrew the medical attitude and his imagination was gradually caught by the general biological laws of nature. It was during his lecturing at Debrecen University, that he decided to teach biology which forms the fundamentals of medical science and gives its theoretical background.

What interested him was not so much man as the whole living world and the ruling biological phenomena in it. Already at the outset of his research had he seen the close connection between structure and function and this idea predominated the evaluation of his scientific results too. The development of the living world, Darwin's theories, left a deep impression in him and he found the greatest pleasure in teaching these ideas in anatomy. Shortly he chang ed the name of his institute to Anatomy and Biology Institute, although in the university curriculum, biology was not mentioned.

In 1932 with the death of professor Kálmán Tellyesniczky, director of the Institute of Anatomy at the Budapest University, he was granted an appointment to the Institute, but according to the development of science and to his ambitions, the name of the Institute was changed to Institute of Histology and Embryology. He thought now he could indulge in his beloved biology and he began to prepare his lectures with great ambition.

However, his strivings clashed at that time with the university spirit which with the wave of fascism tried to eliminate the thoughts of evolution, Darwin's theories, from the University. Huzella had to fight even for the topics of his lectures and he could not realize that it was not the individuals but the fascist rule, which he slowly came to face. Being a bellicose and determined character, these features showed in his faults, too. He set out to fight against tyranny already in Debrecen. On the occasion when once a family had been dislodged to the street that a commander of an army corps, should be secured a flat. He published a pamphlet, distributed it and also in the trial where there was no suitable lawyer who dared to defend his cause he himself performed the duties of the defence. Naturally he was unable to come out of the fight victorious. What incited him in this fight was that being an antimilitarist he considered the army not fighters for peace, but the cause of war.

His Budapest professorship did not give him his teaching freedom, the tension between him and the university committee increased until they forbade Huzella to teach biology. This was even more unusual, as Huzella has — in himself — united liberalism and belief in God without admitting himself to clericalism. His fights in Debrecen and Budapest directed his thoughts towards securing — in the given circumstances — the possibility of undisturbed biological research; so he decided to gather around him students from the university who would insure a modern experimental biological future in Hungary.

From his parents he had inherited in Alsógöd a summer-house with a lovely big garden beside the Danube. Here he saw the possibility of realizing his scientific aims.

He thought that the profits of model gardening would enable him to establish at Alsógöd a private laboratory and with the moral and scientific background of the University he could find the opportunity to develop the Hungarian biological sciences even with the sacrifice of his wealth, income and mind.

Huzella had won by then a great international reputation. Being a natural linguist as a companion for his father's foreign business trips he was able to be ever improving in foreign languages. Hence he was able to lecture and discuss on international congresses held in any of the world-wide languages. In this regard Huzella has achieved many a great success. At these discussions it was his wide literary reading and his special sensitivity for assessing the capabilities of the debating partner and not in the least his extraordinary large vocabulary of the languages which made it possible for him to take up the argument with everyone in the language of the opponent. His scientific works and his attractive human qualities, ensured a significant position for him in the international scientific life. It was thanks to this, that he was elected president of the 3rd International Cell Research Congress in Cambridge, but he was president of many other congresses too.

For running the Alsógöd laboratory, he succeeded in obtaining Hungarian and — especially — foreign help, but all this was not enough. Having slowly exhausted his family fortune and income, he struggled with financial difficulties. At the same time he had to defend himself continually against the attacks of the University, accusing him for taking the laboratory instruments used temporarily in experiments at Alsógöd.

These fights, carried out for the maintenance of the Alsógöd laboratory made his life extremely troublesome. It was refreshing for him to receive foreign researchers visiting him in great numbers at his laboratory, situated in a picturesque setting, with a panoramic view over the Danube. There was hardly a foreign researcher, working in the same field and staying in Hungary who would have avoided Alsógöd. Alexis Carrel the Nobel Prize Winner mentioned, years later, his visit to Alsógöd as one of the highlights of his Hungarian trip and referred to the fervour towards science whereby Huzella sacrificed his own income and family fortune to the research carried out there. In his garden at Alsógöd he experimented with gardening and animal breeding of every possible mode, so as to ensure the necessary financial source for research no matter how unreal the ideas seemed to be. These efforts meanwhile broadened his biological knowledge and convinced him of the importance of a general biological education for the formation of the view a future doctor.

His first scientific works originated from the area of pathology and patho-histology, however, he wrote as his significant works as anatomist, or more precisely as a biomorphologist. The relationship between structure and function struck him first in his work written on atrophy of the liver and led him to the hypothesis, that — besides physical and chemical factors — organizers must also operate in the mechanism of biological phenomena, which being biological factors cannot be examined merely by physical or chemical methods. New methods are therefore required in experimental biology, incorporating physical and chemical procedures and analysing the basic laws of life at a more comprehensive and higher level. This way of thinking was reflected in his work on the connective tissue fibres, especially on the so-called reticular fibres. The latters — due to their affinity to silver ions also called argyrophil fibres — are secreted by the connective tissue cells and assume the pattern of a reticular network during the activity and movement of the cells thus "crystallizing" in the intercellular spaces. The system of the reticular fibres is the gel form of an intercellular colloid protein solution; the fibre system enmeshes every cell and constitutes the framework on which the cells creep like the snail on a thin wire coating it with a material to which the silver staining of the fibres can be attributed. As regards the formation of the intercellular fibre substance, present opinions basically agree with Huzella's ideas, with the difference that our nomenclature today is not the same. According to modern ideas the connective tissue cells secrete the tropocollagen, which by polymerizing, form the intercellular fibres. Huzella attributed to the reticular fibres a so called "active elasticity" by which he meant the dynamic potency of the stretched condition of the fibres, thus playing an active role in the mechanical activity of a biological system. The altered condition of any part of the reticular fibre system involves a change in the state of the whole network, which naturally influences the cell life in the spaces of the network. The living cells are those factors, which maintain the network in a streched condition, keep it in working unities and are the manifestations of the so-called organizational forces.

The movement of the cells is controlled by the reticular fibres both in normal tissue functions and in wound healing or in the formation of neoplastic structures. These thoughts led Huzella to the tissue culture, which had just appeared at that time, as a method with very great experimental possibilities.

In his numerous works he always returns to the idea that the experimental study of the organization and formation of biological structures should be carried out with artificial interference. In tissue cultures he tried to orient the formation of biological structures with the presence of a strong magnetic field. This idea often reappears in international literature and although the biological effect of the magnetic forces is today rather a supposed one as the magnetic effect on the cells cannot be said to be proved. He considered the environmental effects, which came about during the crystallization of biocrystals as organizational forces, and supposed them to be biological factors of tissue growth.

The biological concept connected with the reticular fibres dominated his idea concerning the infiltration mechanism of neoplastic tissues. According to this, the "elastomotor" forces, represented by the reticular fibres exhibiting active elasticity — are the promoting and controlling factors of the wandering of tumour cells. In contrast to the static way of approach which prevailed at that time in morphology, the living organism and the dynamism of the living cells were the guiding principles of his ideas. He was the first in Hungary to study the behaviour of cells and tissues with the aid of time-lapse cinematography.

He summarized his investigations rich in ideas, in his Textbook of General Biology.* This was not a textbook of biology, but rather a summary of his university lectures, containing the ideas that Huzella had concluded from the history of biology and his own investigations. Already in this book it appeared, that Huzella considered the man not merely as a biological but also as a social being and he supposed a similarity between the organization of the living world and human society. His most important work (appeared in German also) was the Intercellular Pathology** in which, contrary to cytology, redirecting the basic laws of the living organism exclusively to the cells, he emphasizes the importance of the intercellular substance. He presumed to find the controlling factors of the biological organization and development in cell interrelations and interactions.

In a speech on the occasion of the 100th anniversary of cytology in 1932, he pointed to the fact that cytology and intercellular science together are only able to explain the normal and pathological life processes. He writes: "Die intercelluläre Lehre stellt die von der Histologie überaus wenig in Betracht gezogene extracelluläre Bildung der in den Gewebeelementen verborgenen intercellulären Faktoren in den Vordergrund." The ideas, raised in Huzella's theories and works, are actual problems of morphology even today. He was that type of scientist, who did not work on minute systematic analysis, but appreciated elegant experimental work supporting great ideas. His work is therefore full of natural philosophy and synthesis based on a wide knowledge of natural science. A witty idea that occurred to him during occasional readings would give him just as much pleasure as an occasional successful experiment.

He considered the reticular fibre system as the morphological expression of the unity of function and structure; according to him this system was not a rigid network, but a basic structure continually changing in compliance with function. Huzella saw in the reticular fibre system that integrating factor, which coordinated the biological organization of cell groupings.

He belonged to that group of Hungarians whose reputation meant more abroad than in this country. His cultured, witty character, his manifestations free from narrow-mindedness, his ardent love of science raised him to an imposing figure of international and foreign congresses. At these, as a leading personality he worthily represented Hungarian science and his argumentations, made for the cause of free individual acceptance, brought him in friendly contact with numerous great individuals. In this way he carried on a valuable correspondence with Romain Rolland, Alexis Carrel, Ross Harrison etc., with whom the relationship no doubt would have brought valuable fruit in his later years of work had he not been taken by an early death.

It was his conviction that the significance of biological sciences would grow day after day in human society. In his studies we can read social Darwinism and social biological ideas between the lines. His speculations on this were written in his book: "War and Peace from Medical Aspect. Outlines of Medical Sociology". (Budapest, 1923 Eggenberger's Publishing Company), which also appeared in a French edition. He considers war as the illness of the society

* Hungarian Medical Book Publishing Company, 1933.

** Cellular Community in the Perspective of the Intercellular Theory and Intercellular Pathology. University Press, 1942, Budapest.

to be cured by the open-minded natural scientist. This work contains several contradictions, which can be discussed, but his sparkling daring thoughts and examples show that direction in which the healthy Huzella would have developed had he lived in a healthier social life.

Huzella could not live to see the time in which general biology became the official subject in medical teaching. Exhausted from struggles and debates the Second World War befell him when with the privations caused by the siege of Budapest his health was undermined.

This resulted in his retirement, which, however, did not help his condition either and in 1951 at the age of 64 he died at Alsógöd. He is buried there in the family laboratory garden, that had played such a big part in his life. His laboratory was transformed to the Danube Research Laboratory of the Hungarian Academy of Sciences and the Biological Experimental Laboratory of the Eötvös Loránd University. The research station brought to life by Huzella today still serves science and is one of the bases for the training of Hungarian biologists.

I. Törő

Acta Agronomica Academiae Scientiarum Hungaricae 17 (3—4), pp. 457—461 (1968)

RECENSIONES

E. LAZÁNYI: *Fontosabb termesztett növényeink ivaros szaporodásáról* (Sexual Reproduction of more Important Cultivated Plants). Mezőgazdasági és Erdészeti Állami Könyvkiadó (Agricultural and Forestry Book Publishing Company). Bucharest, 1957.

There are many publications in world literature, giving general and detailed information on cultivated plants, connected with the diverging problems of their sexual reproduction. Plant growing, especially the seed growing and plant breeding specialists have great need of obtaining information easily. The collection of data found dispersedly in world literature, requires such great efforts, that the specialist in practice cannot undertake to procure them. So they badly need the necessary knowledge.

It is just here that the author wishes to improve the situation by presenting the more important informations to the readers.

Although this book was intended for the "middle grade technicians", the author thinks it will be received with interest by the "higher grade specialists", too.

The work consists of five chapters, totalling together with the literature and index 211 pages.

The first chapter is "The Origin and Phylogeny of Sexual Reproduction in Plants". It describes the more important types and the phylogenetic course of sexual reproduction, from unicellular to phanerogamous plants.

The second chapter, the "General Information on Sexual Reproduction of Angiospermous Plants", deals with the morphology and cytology of the reproductive organs, sexual fertilization, as well as the process of development of the seed and crop.

The physiology of sexual reproduction of angiosperms is discussed in the third chapter, where the sexuality of phanerogamous plants, the importance of the developmental phenomena, and the different ways of flowering and pollination came up for discussion.

In the fourth chapter, the physiological problems of pollen are dealt with in detail. The author discusses here the physiological characters of pollen and fertilization, the physiological methods of pollen and the medium components, which are necessary for the "germination" of the pollen and the growth of the pollen tube. Moreover the germination of the pollen mixture, the effect of the pH on the "germination" of pollen, the optimal temperature for the "pollen germination", as well the questions connected with the drought resistance of pollen are presented.

The biology of flowering of the more important cultivated plants and the cross-fertilization techniques are introduced in the fifth chapter. At first the general problems of cross-fertilization are dealt with in detail, and then the author turns to the data of certain species. The book publishes the data of the biology of flowering in the following species: wheat, rye, barley, oat, maize, potato, sugar-beet, pea, bean, lupin, soybean lens, pumpkin kinds, sunflower, cotton, hemp, flax, poppy, tobacco, apple, pear, plum, cherry, sour-cherry, peach, apricot. The writing up of all of these plants, is naturally not of the same size (the data are represented to a greater or lesser extent), but in case of the species discussed in detail, the following are published: the biology of the flowering of species and the development of the flower, flowering and fertilization, castration and artificial pollination, heterosis, as well as cross-fertilization.

The book usefully summarizes the most important informations on sexual reproduction of the cultivated plants for the less informed specialists, in fact for anybody, who is interested in this subject.

GY. MÁNDY

Differentiation of Apical Meristems and Some Problems of Ecological Regulation of Development of Plants. Academia, Praha 1966.

The work published by the Czechoslovakian Academy of Sciences in 1966, is a review on the material of the symposium held in Praha—Nitra from August 30 to September 6, 1964. The international symposium was organized under the joint auspices of the Experimental Botanical Inst. of the Czechoslovakian Acad. Sci., of the Genetical and Plant Biological (Plant Physiology) Institute, Praha, as well as of the Agricultural College, Nitra.

The subject of the symposium was the differentiation of apical meristems and some problems of ecological regulation of plant development. These topics are sure to command interest for experts as well as for scientific researchers. This is also demonstrated by the following data: Twelve countries took part and altogether fifty-five lectures were delivered at the symposium; each of these lectures can be found in this publication. Twenty-two of the lectures were held by the researchers of the country arranging the symposium, while thirty-three lectures were made by foreign authors.

From the lectures of the symposium it can be established to what great extent attention has recently been paid to the anatomic and cytologic problems of the differentiation of apical meristems as well as to the efforts made to try to characterize and explain the phenomena on the basis of their biochemical relations.

The problems of the differentiation of the apical meristems and of the exterior development of plants are also very important in studying the onto- and, partly, the phylogenesis of organisms. Problems related to these can be solved only through special studies connected with the developmental processes as well as by applying experimental and compound methods. Cytology in itself is also of major importance; in connection with the ontogenesis of organisms it follows closely behind the continuous change of the inner structure of the meristem. It renders possible to make such valuable statements as e.g., in connection with the peculiar way of formation of the meristem structure, the fact that the apical meristem-structure is relatively unchanged in inferior plants whereas it is variable in the superior ones. Experimental cytology and especially cytochemistry are likely to submit further data regarding the problems of development and of differentiation. Thus, when studying ontogenesis, observations made from morphological and structural viewpoints are far from being sufficient. In that way the processes of the development of meristems can be proved mechanically only; the complicated processes of the effect of external factors on the cell can be traced in a few simple relations only. Therefore, the cytochemical investigations are nowadays indispensable. Besides, very promising results might also be expected from observations made on the tissue-cultures of the isolated cells.

In this publication several papers discuss the recent results obtained in general problems, while some papers deal with special subjects. The book is divided into the following chapters: Anatomy (6 lectures); physiology, biochemistry, hystochemistry (21 lectures); experimental morphology (12 lectures) environmental biology (11 lectures); utilization in agriculture (5 lectures).

The 21 lectures in physiology, biochemistry and hystochemistry show, also by the number of the lectures, that nowadays the developmental processes of the meristem can by no means be restricted to observations made only from morphological and structural viewpoints. Within the frame of this, several lectures have dealt with the role and effect of ghiberellic acid; with the biochemical aspects of the process of vernalization; with studying, in vitro experiments, the effect of materials that stimulate growth, etc.

Besides the valuable lectures of the symposium, the publication includes also the discussion, the literary abstracts of the lectures delivered, and submits even the material of demonstration. Twenty pictures, several figures and tables contribute to the better understanding of the material of the symposium.

Thus, possibility is rendered for the researchers dealing with problems of plant development in different countries, to get an inside view of the scientific material of that valuable, incentive and useful symposium.

Á. KÉRY

R. SOÓ: *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve* (Taxonomic-Plant Geographical Manual of the Hungarian Flora and Vegetation.) I—II. Akadémiai Kiadó (Publishing House of the Hungarian Academy of Sciences). Budapest, 1964, 1966.

The publishing of the first book of the vast work planned in five volumes, and written by R. Soó is again an important landmark in the research work of the Hungarian flora and vegetation.

As stressed by the author in his preface, this work is destined to supply, to some extent, the book by SOÓ—JÁVORKA, which has been quickly sold out; the taxonomic keys will be contained in the edition: "The Hungarian flora" to be published in 1968. Those, however, who take the book in their hand will immediately see that the work in question is quite different in its construction, ideas and volume.

The work does not include the *Thallophyta* — other ones have to do so — neither does it deal with most of cultivated plants going into sorts since in the series called "Cultivated Plants in Hungary" the *Spermatophyta* will have already been included. Instead, author submits a much more detailed description of species and intraspecific taxa, furthermore their locality as well as their coenologic conditions, their area-types, their chromosome number and the incidental medical or other economical bearings — and all this in such a detailed manner that cannot be compared with any other work in home, even in foreign literature.

The very detailed character of the work aiming at theoretical botany, renders it suitable for being a basic source for applied botany too, in which answers and data can be found to many a question raised by growers in different fields crops, by gardeners, foresters, garden designers and plant breaders.

In what this work considerably differs from similar ones and what greatly adds to the value and practicability of it, are the first, general part of Vol. I and the second chapter treating the plant geography of Hungary.

In the "Introduction" author submits the necessary information on serial number, specific name, synonyms, the definition of intraspecific categories and species, cytotaxonomic data, the area, the floristic and oecological features, flower biology data, the role of coenology and other observations as well as literary references.

In the first chapter of General Part I taxonomic fundamental ideas and taxonomic units are discussed. The second chapter deals with the rules of nomenclature. This chapter is of special importance as those interested might get acquainted here with the most important rules being valid now, however, difficult ones to get at in Hungarian language. Chapter 3 gives a survey on the system of treated groups while chapter 4 summarizes the oecological fundamental ideas. This is followed by Chapter 5 outlining flora elements, then by Chapter 6 treating coenologic fundamental ideas while in the 7th chapter author submits systematic outlines of home phytocoenology. The great importance of that part is that, along with submitting the latest issues — the reader of the book can be made well acquainted with the most modern notions and divisions, respectively.

Part II discusses the plant geography of Hungary. The first chapter gives a brief history of vegetation in Hungary. Chapter 2 deals with the floristic and coenological plant geography on the basis of the new arrangement. In this chapter we find, according to sectors and regions, partly a very detailed enumeration of flora-elements, partly the coenological and floristic characterization of certain floristic provinces and districts. The 3rd chapter of Part II discusses the critical system of home phytocoenoses in such detailed manner that will call attention and deserves credit not only at home but abroad, too. This chapter discusses the phytocoenoses enumerated in the 7th chapter of the general part, and partly tries to throw light on synonymics becoming more and more important, partly quotes all works in which literary references can be found concerning the nomenclature of coenoses and their presence in this country. That part submits fundamental synopsis for the meadow- and pasture management, the forest-typology, as well for garden planning and lay-out. To this are added an easy-to-survey and detailed bibliography and a list of abbreviations used in the text and comprising the names of periodicals, the form of growth, the phytocoenoses, the names of authors and other abbreviations, too. The list of authors is the first one in literature containing also the coenological authors and also containing many biographical data unpublished so far.

Then follows the 3rd part including the taxonomic elaboration of higher (cauliferous) plants and plant-geography characterization according to the above-mentioned principles.

The comprehensive part (353—510 pp) treating mosses, is the work of Á. Boros. Data on the occurrence of plants are mostly due to the painstaking search done for several decades of the above author as well as L. Vajda, while coenologic data were compiled mostly by R. Soó and T. Pócs.

Ferns are discussed by R. Soó. A special value of this part is that author makes use of the results of G. Vida who had often elucidated the problems of our indigenous ferns with the most modern cytogenetic methods. The part discussing ferns starts as well with literary references and contains both taxonomically and coenologically a detailed description of the new results of pteridologic research.

This is followed by the description of the *Gymnospermae:* the literary reference of which is found with the *Pinaceae.* Besides the few species growing wild, this chapter includes also the most frequent cultivated species.

At the end of the book consisting of 589 printed pages, the different registers (index, coenologic units, taxonomic units, names of authors) are submitted by Sz. Priszter.

The first part of the work planned in several volumes, shows already its exceedingly great importance. Besides the valid names of the critically revised associations, readers can get partly full literary references together with quotations of sources, partly the present names of species, their most important synonymy, variability range, critical evaluation, the cytotaxonomic, arealgeographic and coenologic data which, all in all, may serve as substitute for a whole library.

The work contains not only the results obtained so far in the research work done in Hungarian flora and vegetation and is not only an important source and basis of future theoretical and practical research in this country, — it is also an indispensable source especially for the neighbouring countries.

It has been written by the author in Hungarian in such a way as the most essential parts of it can be understood by those not knowing our language. This is greatly contributed to by the subsequently edited index written in foreign languages rendering the work fully practicable abroad, too.

The second volume published in 1966 containing the entire first branch of the dicotyledonous plants *(Dicotyledonopsida)* and the 14 classes of same ranging from the *Magnoliales* to the *Dipsacalês*, as well as the second branch' 4 classes ranging from the *Malvales* to the *Ligustrales*, is a worthy continuation of the first volume.

The Introduction of Vol. II submits a brief list of contents of the first vol., and the German and English equivalents of abbreviations used in the work in order to make the book easier to be used abroad.

The Preface informs us on certain alterations as compared with the first volume. Though the text itself treats primarily the indigenous wild-growing species, — we find there also not only cultivated plants, vine, fruits, vegetables and ornamental plants, under their up-to-date namings — but the year of description for the species its original country and life-form and also the cytological data.

The work has a special importance by giving the modern microsystematical treatment of certain groups of characters, thus e.g. the elaboration of the genera *Pyrus*, *Sorbus*, *Crataegus*, *Rubus*, *Rosa*, *Prunus*, *Cytisus*, *Acer*, *Tilia* and *Fraxinus* being very important from the viewpoint of dendrology. Of the herbaceous plants e.g. the taxonomical division of the flax is very important for agriculture.

The make up is equal to the content of the work. The Publishing House of the Academy of Sciences did their utmost. The exterior of the two volumes, the editorial and correcting work as well as that of printing deserves all acknowledgment. As a result of the cooperation of author and editor our special literature grew richer with a work that is an important and indispensable source of different branches both of theoretical and applied botany thus representing our science and publishing of books in a worthy way at home as well as abroad.

Z. E. KÁRPÁTI

Printed in Hungary

A kiadásért felel az Akadémiai Kiadó igazgatója Műszaki szerkesztő: Farkas Sándor
A kézirat nyomdába érkezett: 1968. IV. 12. — Terjedelem: 16,25 (A/5) ív, 78 ábra

68.65466 Akadémiai Nyomda, Budapest — Felelős vezető: Bernát György

INDEX

VARIA

CHRONICA

RECENSIONES

HEREDITY

An International Journal of Genetics

WEED RESEARCH

Official Journal of the

EUROPEAN WEED RESEARCH COUNCIL

CONTENTS

Vol. 8, No. 2 Tone 1968

The subscription price is 105*s. post free, per annual volume of four parts. Single parts are* 30*s. each, postage extra.*

BLACKWELL SCIENTIFIC PUBLICATIONS LTD.

OXFORD AND EDINBURGH

CANADIAN JOURNAL OF PLANT SCIENCE

The Agricultural Institute of Canada organized in 1920 publishes the Canadian Journals of Plant, Animal and Soil Science. These publications are devoted to the publication, in English and French, of the results of original scientific research in the fields of Plant, Animal and Soil Science.

The Canadian Journal of Plant Science is published bi-monthly; six issues making up a volume of some 600 pages a year, size 24.7 × 16.5 cm.

The publication charge payable by all authors has been reduced to $25 per printed page; however, free reprints are no longer provided. Price quotarions for reprints are provided with the galley proofs, and reprints should be ordered when the proofs are returned to the Editorial Office.

Manuscripts for publication and all correspondence should be addressed to the Editorial Office. Subscriptions are $13 per year, including postage; single copies, $3.50.

Editorial Office – Agricultural Institute of Canada,
151 Slater Street,
Ottawa 4, Ontario.

The Agricultural Institute of Canada also publishes the Agricultural Institute Review bi-monthly.

Die Acta Agronomica veröffentlichen agrarwissenschaftliche Abhandlungen, besonders aus dem Bereich der landwirtschaftlichen Grundforschung, in englischer Sprache.

Die Acta Agronomica erscheinen jährlich in einem Band (4 Hefte).

Die zur Veröffentlichung bestimmten Manuskripte sind an folgende Adresse zu senden:

Acta Agronomica
Martonvásár, Postafiók 19.

Abonnementspreis pro Band: 165 forint. Bestellbar bei dem Buch- und Zeitungs-Außenhandels-Unternehmen »Kultúra« (Budapest I., Fő utca 32. Bankkonto Nr. 43-790-057-181) oder bei seinen Auslandsvertretungen und Kommissionären.

Les Acta Agronomica publient des communications, en langue anglaise, dans le sujet de la science agricole, surtout du domaine des recherches fondamentales agronomiques.

Les Acta Agronomica sont publiés sous forme de fascicules qui seront réunis en un volume par an.

On est prié d'envoyer les manuscrits destinés à la rédaction à l'adresse suivante:

Acta Agronomica
Martonvásár, Postafiók 19.

Le prix de l'abonnement est de 165 forints par volume.

On peut s'abonner à l'Entreprise pour le Commerce Extérieur de Livres et Journaux «Kultúra» (Budapest I., Fő utca 32. Compte-courant No. 43-790-057-181) ou à l'étranger chez tous les représentants ou dépositaires.

Acta Agronomica публикует статьи по аграрной тематике, главным образом теоретические работы в области сельскохозяйственных основных наук.

«Acta Agronomica» выходит выпусками, составляющими один том в год.

Предназначенные для публикации рукописи следует направлять по адресу:

Acta Agronomica
Martonvásár, Postafiók 19.

Подписная цена «Acta Agronomica» — 165 форинтов за том. Заказы принимает предприятие по внешней торговле книг и газет «*Kultúra*» (Budapest I., Fő utca 32. Текущий счет № 43-790-057-181) или его заграничные представительства и уполномоченные.

72, — Ft

Reviews of the Hungarian Academy of Sciences are obtainable at the following addresses:

ALBANIA

Ndermarja Shtetnore e Botimeve
Tirana

AUSTRALIA

A. Keesing
Box 4886, GPO
Sydney

AUSTRIA

Globus Buchvertrieb
Salzgries 16
Wien I

BELGIUM

Office International de Librairie
30, Avenue Marnix
Bruxelles 5

Du Monde Entier
5, Place St. Jean
Bruxelles

BULGARIA

Raznoiznos
1, Tzar Assen
Sofia

CANADA

Pannonia Books
2, Spadina Road
Toronto 4, Ont.

CHINA

Waiwen Shudian
Peking
P. O. B. 88

CZECHOSLOVAKIA

Artia
Ve Směčkách 30
Praha 2

Poštová novinová služba
Dovoz tisku
Vinohradská 46
Praha 2

Mad'arská Kultura
Václavské nám. 2
Praha I

Poštová novinová služba
Dovoz tlače
Leningradská 14
Bratislava

DENMARK

Ejnar Munksgaard
Nörregade 6
Copenhagen

FINLAND

Akateeminen Kirjkauppa
Keskuskatu 2
Helsinki

FRANCE

Office International de Documentation et Librairie
48, rue Gay Lussac
Paris 5

GERMAN DEMOCRATIC REPUBLIC

Deutscher Buch-Export und Import
Leninstraße 16
Leipzig 701

Zeitungsvertriebsamt
Clara Zetkin Straße 62
Berlin N. W.

GERMAN FEDERAL REPUBLIC

Kunst und Wissen
Erich Bieber
Postfach 46
7 Stuttgart S.

GREAT BRITAIN

Collet's Holdings Ltd.
Dennington Estate
London Rd.
Wellingborough. Northants.

Robert Maxwell and Co. Ltd.
Waynflete Bldg. The Plain
Oxford

HOLLAND

Swetz and Zeitlinger
Keizersgracht 471—487
Amsterdam C

Martinus Nijhof
Lange Voorhout 9
The Hague

INDIA

Current Technical Literature
Co. Private Ltd.
India House OPP
GPO Post Box 1374
Bombay I

ITALY

Santo Vanasia
Via M. Macchi 71
Milano

Libreria Commissionaria Sansoni
Via La Marmora 45
Firenze

JAPAN

Nauka Ltd.
92, Ikebukur O-Higashi 1-chome
Toshima-ku
Tokyo

Maruzen and Co. Ltd.
P. O. Box 605
Tokyo-Central

Far Eastern Booksellers
Kanda P. O. Box 72
Tokyo

KOREA

Chulpanmul
Phenjan

NORWAY

Johan Grundt Tanum
Karl Johansgatan 43
Oslo

POLAND

RUCH
ul. Wronia 23
Warszawa

ROUMANIA

Cartimex
Str. Aristide Briand 14—18
București

SOVIET UNION

Mezhdunarodnaya Kniga
Moscow G—200

SWEDEN

Almquist and Wiksell
Gamla Brogatan 26
Stockholm

USA

Stechert Hafner Inc.
31. East 10th Street
New York, N. Y. 10003

Walter J. Johnson
111, Fifth Avenue
New York, N. Y. 10003

VIETNAM

Xunhasaba
19, Tran Quoc Toan
Hanoi

YUGOSLAVIA

Forum
Vojvode Mišića broj 1
Novi Sad

Jugoslovenska Knjiga
Terazije 27
Beograd

29. VI. 1968

Index: 26.001